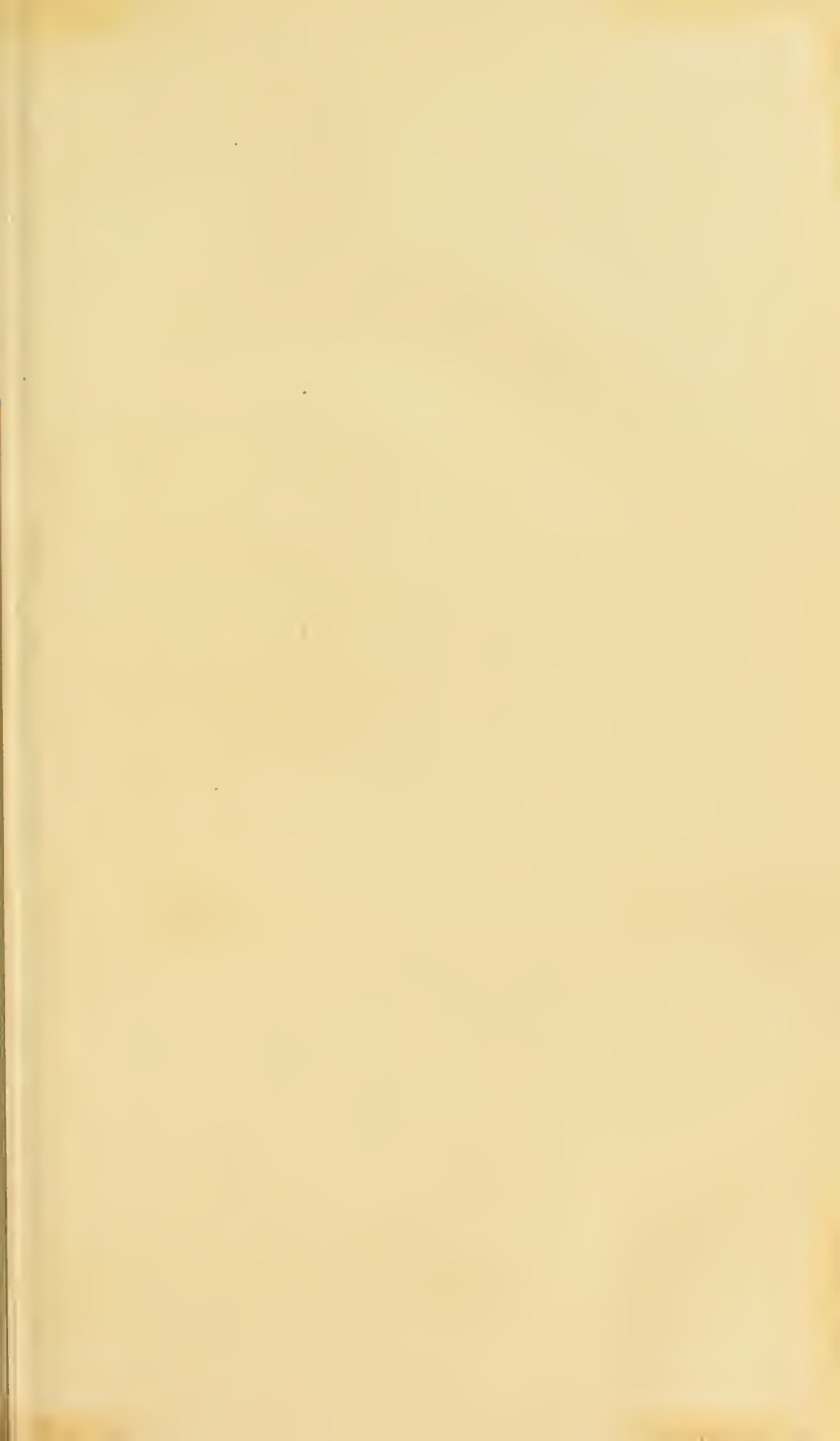


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ON THE

CHEMICAL DISCRIMINATION

OF

VESICAL CALCULI.

BY E. A. SCHARLING, A.A., L.L.M.

PROFESSOR OF CHEMISTRY IN THE UNIVERSITY AND POLYTECHNIC
SCHOOL, COPENHAGEN.

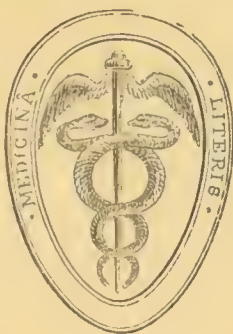
TRANSLATED FROM THE LATIN,

WITH AN APPENDIX,

CONTAINING PRACTICAL DIRECTIONS FOR THE RECOGNITION OF
CALCULI,

BY S. ELLIOTT HOSKINS, M.D.

With Plates.



LONDON:

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P R E F A C E.

IN the course of the investigations I have long been engaged in, on the subject of solvents for urinary calculi; full details of which will ere long be made known, my attention was attracted by a notice of Dr. Scharling's Essay; in the British and Foreign Medical Review, (1840,) to the following effect.

The work of M. Scharling, says the reviewer, contains matter deeply interesting to those who wish to engage in chemical researches on the properties of calculi. In most other treatises the characters of the varieties are given individually, so that an analysis seems to be a very

simple operation; this, however, owing to the peculiar reactions of one substance obscuring those of another, is seldom the case. M. Scharling's is the only treatise in which rules for separating the usual mixtures of calculi from each other, are clearly and succinctly described. They have, it must be remarked, the merit of being deduced from actual analyses.

Finding, on reference to the original work, that its value was not overrated, I was induced to condense and arrange it, as a text book for my own use; regretting, nevertheless, that its utility should be so narrowly circumscribed: without the plates, however, it would have been useless to have thought of publishing. Circumstances subsequently led to a correspondence with the author, who, with the utmost liberality, placed the original wood-cuts at my disposal. With this additional inducement, I did not hesitate to prepare a translation for the public, under the hope, that it might prove to others, as practical a guide, in the discrimination of calculi, as it had been to me.

The mode of classification adopted by Dr. Scharling contributes, not a little, to facilitate examination; although it is a mere modification of that proposed, or at all events, recommended by Dr. G. O. Rees. The latter gentleman only divides calculi into two groups; those which are destructible by a red heat, and those which are not. Now, it constantly happens, that calculi consist of both kinds of ingredients; the inexperienced analyst is at a loss to determine which predominates, and consequently hesitates as to the class under which he is to place the specimen. Dr. Scharling obviates this difficulty by instituting a third class,—the *partially* combustible, including calculi in which the nature of the combustible, as well as the incombustible constituents, require to be ascertained.

In my Appendix I have ventured upon a slight alteration of the author's arrangement; intended to simplify the recognition, not only of the different groups, but of the individuals composing them. With this view, the blowpipe characters, peculiar to each variety, have been

added. They are so distinctive as to supersede, in most cases, the necessity for having recourse to further chemical examination. Should the latter however, be required, a list of reagents, and of the manner of employing them, has been appended; as also a tabular view of the sensible characters, and distinguishing chemical properties, of the various species of calculi. In the compilation of this Appendix my aim has been to condense as much practical information as possible into a small space, for the benefit of the practitioner whose avocations oblige him to read as he runs; who must carry his apparatus in his waistcoat pocket, or be indebted for the means of manipulation to the materials and implements he chances to meet with in ordinary habitations.

It was my intention also to have given a *résumé* of the action of reagents on urine, and of its occasional deposits; but the subject has been so ably treated by Mr. Coulson,* that anything further would be superfluous. The first chapter of his newly-published edition, condenses all that

* On Diseases of the Bladder and Prostate Gland, 3rd edition.

is necessary, in a practical point of view, relative to the substances contained in healthy and diseased urine.

M. Scharling's treatise originated, it appears, in a suggestion of Professor Withusen's, who deemed, that a descriptive catalogue of the calculi in the Royal Surgical Museum of Copenhagen would be useful to those who were inclined to inspect that ample collection. During the progress of the undertaking, which was confided to Dr. Scharling, this gentleman became impressed with the idea, that more general utility would be attained, by illustrating the descriptions with accurate delineations of the calculi. The plan, on being mentioned to the proper authorities, was appreciated and adopted; and funds were at once placed at M. Scharling's disposal for the purpose of carrying out his design.

The advantages contemplated by the execution of the plates with which the work is enriched, are likely to be greater than could have been anticipated; in consequence of the opportunity which will soon be afforded, by means of splendid engrav-

ings, now in course of publication, for comparing the specimens in the Copenhagen collection, with those in the museum of the London Royal College of Surgeons.

Very few years ago, the profession was constrained to rest satisfied with, and be thankful for, verbal descriptions of the specimens contained in the different collections ; but the facilities which art now affords for the illustration of science ; and the disposition which prevails for the diffusion of information, promise soon to render the museums of different nations, as it were, common property. It is much to be desired, that the rich collection in the museum of Guy's Hospital, should be delineated in a manner worthy of the institution, and of the elegant and graphic account of the calculi recently published by Dr. Golding Bird.

To return to M. Scharling, his essay is dedicated to his relative, the venerable Oersted, of Electro-magnetic celebrity ; and the preliminary address, which I have deemed it better to embody in this preface, than to translate in full, concludes with acknowledgments to Professors

Withusen and Jacobson, together with Drs. Christensen and Starke for the assistance they have rendered, in affording him free access to their private collections

GUERNSEY, *Sept.* 20th, 1842.

DESCRIPTION OF THE PLATES.

Fig. 1. Chiefly composed of uric acid. The nucleus *a*, and adjacent layers *b*, contain oxalate of lime, with uric acid and urate of ammonia; these are surrounded by, *c* and *d*, layers of uric acid, more or less dense. *Weight*, 8 oz. 60 grs.

2. The nucleus, *a*, and the layer, *b*, uric acid; the intervening layers, and those external to *b*, consist of urate of lime and ammonia. The cortex, *c* and *d*, is composed of fusible matter, with a large proportion of triple phosphate. *Weight*, 4 oz.

* The figures are coloured from specimens previously moistened, to render the tints of the laminæ as distinct as they are in recent calculi.

3. The strata, *a*, which are of varying density, consist of uric acid; *b*, urate of ammonia; the cortex is composed of fusible matter. *Weight*, 2 oz. 30 *grs.*

4. No distinct nucleus, the centre occupied by a loose mass of uric acid, surrounded by a denser layer of the same, *a*; the external coating, *b*, fusible matter. *Weight*, 1½ oz. 180 *grs.*

5. A perfect specimen of the hollow, fissured calculus, apparently made up of segments connected edgeways. From the collection of Professor Jacobson. See p. 29.

6. Consists entirely of uric acid. *Weight*, 1 oz. 180 *grs.*

7. Uric acid. *Weight*, 1 oz. 87 *grs.*

8. *a*, uric acid; *b*, uric acid and urate of ammonia; *c* and *d*, fusible matter; *f*, triple phosphate, in large crystals, studding a great portion of the surface; *e*, uric acid, a very thin layer coating the phosphate. *Weight*, 5 oz. 180 *grs.*

9. Similar to No. 8, with the addition of urate and oxalate of lime; the irregular structure of

the latter very apparent, as contrasted with that of the nucleus and cortex.

10. The body, *a*, grey urate of ammonia; variegated at *c* and *b* with uric acid; cortex fusible matter. *Weight* $1\frac{1}{2}$ oz. 66 grs.

11. *a*, uric acid and urate of lime; *b*, oxalate of lime; *c*, fusible matter. *Weight*, $1\frac{1}{2}$ oz. 60 grs.

12. Alternate layers of oxalate of lime, *a*; and uric acid, *b*. *Weight* $\frac{1}{2}$ oz. 90 grs.

13. Body, *a* and *b*, uric acid; the nucleus consists of oxalate of lime and dried blood.

14. The surface of the same calculus, *a*, *b*, *c*, showing the effects of solvents in the bladder. *Weight*, $1\frac{1}{2}$ oz. 120 grs.

15. *a*, oxalate of lime and fibrous matter; *b*, uric acid; *c*, uric acid with urates of ammonia and lime. *Weight*, 1 oz. 170 grs.

16. *a*, urate of ammonia, with a trace of fusible matter, the latter increasing in quantity as it approaches *b*. *Weight*, $\frac{1}{2}$ oz. 70 grs.

17. *a*, oxalate of lime, unaffected by the sol-

vents which have acted on the uric acid, *b, c, d, e*.

18. *a* and *b*, parts of the surface acted upon by solvents; *c* and *e*, portions unaffected by the solvents; *d*, portion of cortex, consisting of urates and phosphates. The internal composition similar to that of Fig. 3. *Weight*, $1\frac{1}{2}$ oz. 30 grs.

19. *a* and *b*, uric acid; *c, d, e*, points acted on by solvents.

20. The same calculus, *f*, uric acid, apparently formed previous to *g*, which consists of urate of ammonia; *h*, the cortex, consisting of urate of ammonia, with a small quantity of fusible matter. *Weight*, 1 oz. 95 grs., p. 27.

21. Mulberry calculus; *a*, nucleus; *b* and *c*, the external layers, showing their peculiar and eccentric arrangement. *Weight*, $\frac{1}{2}$ oz. 30 grs.

22. The nucleus consists of alternations of urate and oxalate of lime; the succeeding layers, *a*, uric acid; followed by *b*, and *c*, which are composed of uric acid and urate of ammonia.

The structure is interrupted by considerable fissures.

23. *a*, uric acid ; *b*, uric acid and urate of ammonia ; *c* and *d*, cortex of fusible matter ; *b*, intermediate layers of oxalate of lime. *Weight*, $\frac{1}{2}$ oz. 150 *grs*.

24. *a*, the cortex uric acid, with a small portion of fusible matter ; *c*, the nucleus, urate of lime ; *b*, intermediate layers of oxalate of lime. *Weight*, $2\frac{1}{2}$ oz. 200 *grs*.

25. The nucleus, *a*, urate and oxalate of lime ; cortex, *c*, fusible matter and oxalate of lime, rather spongy and crystalline : *b* and *d*, intermediate layers of the same ingredients, alternately loose and compact.

26. *a* and *b*, two nuclei of uric acid, surrounded by layers of grey urate of ammonia.

27. The nucleus, *a*, urate and oxalate of lime ; *b* and *c*, uric acid ; the cortex is composed of urate of ammonia, and the intermediate layers chiefly of fusible matter. *Weight*, 8 oz.

28. The calculus referred to in page 18. It contains sand and other extraneous matters, but

is chiefly remarkable on account of its gradual decrease of weight. It is also an example of the fissured calculus.

29. An example of the abrupt cessation, and change of direction in the layers ; from being convex they assume a concave curvature. See p. 27.

30. *a*, the nucleus uric acid, with urate and oxalate of lime ; *b*, oxalate of lime ; *c*, uric acid and urate of ammonia, showing the alternation of compact and loose layers ; the cortex is triple phosphate. *Weight*, $\frac{1}{2}$ oz. 120 grs.

31. *a*, uric acid, with urate of lime gradually passing into oxalate of lime, *b* ; *c*, the outer surface uric acid, studded with sharp crystals of triple phosphate. *Weight*, $\frac{1}{2}$ oz.

32. *a*, uric acid and urate of lime ; *c*, uric acid ; *b*, oxalate of lime and dried blood ; the coating consists of a black pigment, soluble in potash and dilute acid. *Weight*, 1 oz. 233 grs.

33. The nucleus, *a*, urate and oxalate of lime, surrounded by a black margin of oxalate of lime and dried blood ; *b*, uric acid ; *c*, urate of ammonia ; *d*, uric acid ; the whole surface covered by

a thin layer of fusible material. *Weight*, $\frac{1}{2}$ oz. 180 *grs.*

34. The nucleus, *a*, uric acid ; *b*, urates of ammonia and lime ; *c*, oxalate of lime ; the cortex, *d*, fusible matter ; the layers between *b* and *c*, oxalate of lime. *Weight*, 200 *grs.*

35. The nucleus, *b*, urate of lime ; *c*, oxalate of lime constituting the body ; *a*, cortex, fusible matter. *Weight*, $\frac{1}{2}$ oz. 160 *grs.*

36. The nucleus, *a*, and the body, *b*, oxalate of lime ; *c*, white crystals of triple phosphate, imbedded in dried blood. Sp. gr. 2.014 ; nevertheless it was spongy. *Weight* $\frac{1}{2}$ oz. 23 *grs.*

37. The nucleus, *a*, and the layer, *b*, uric acid, with urate and oxalate of lime ; *c*, fusible matter. *Weight*, 1 oz. 10 *grs.*

38. The nucleus urate and oxalate of lime ; *b*, uric acid, gradually passing into triple salt. *Weight*, $\frac{1}{2}$ oz. 36 *grs.*

39. *a* and *b*, a fragment of bone, around which is deposited fusible matter, *c* and *d*, with urate of lime and phosphate of lime in crystals. *Weight*, 1 oz.

40. *a, b, c, e*, four different fissures; nucleus, *d*, without any fissure; there are four nuclei bound together by an external coating, *f*. The whole consists of phosphate of lime. *Weight*, $1\frac{1}{2}$ oz. 150 *grs*.

41. Cubical calculus; the nucleus, *a*, and the layers immediately surrounding it, *b*, are uric acid; the cortex, urate of magnesia, with urates of magnesia and ammonia; the surface, *c* and *d*, strewed with crystals of fusible matter. This is the calculus described by Christensen.

42. Calculus of a tetrahedral figure, consisting of urates of magnesia and ammonia, with uric acid.

43. An example of a double nucleus; *a* and *d*, the nuclei separated by a fissure; *b*, spongy layers; *c* and *e*, cortex. The body consists of phosphate of lime. *Weight*, 4 oz.

44. A calculus composed entirely of crystallized triple phosphate. *Weight*, 1 oz.

45. *a*, uric acid and urate of lime; *b*, uric acid, with a small quantity of urate of ammonia; *d*, fusible matter; *c*, phosphates and urates. *Weight*, 90 *grs*.

46. Entirely composed of fusible matter. *Weight*, $10\frac{1}{2}$ oz. 48 *grs.*

47. *a*, compact uric acid ; *b*, spongy uric acid ; *c*, phosphate of lime ; *d*, uric acid, with urate of ammonia and phosphate of lime ; cortex, fusible matter. *Weight*, 220 *grs.*

48. A mass of crystals of triple phosphate, *a* ; *b*, fusible matter. *Weight*, 180 *grs.*

49. Entirely composed of triple phosphate.

50. Entirely composed of carbonate of lime. *c*, internal mass ; *b*, cortex, sprinkled on the surface with crystals of triple phosphate ; *a*, intermediate layers. This calculus was taken, after death, from a horse which had attained the age of nine years. When quite dry, it *weighed* 5 oz.

FIG. 1.





FIG. II.



FIG. III.

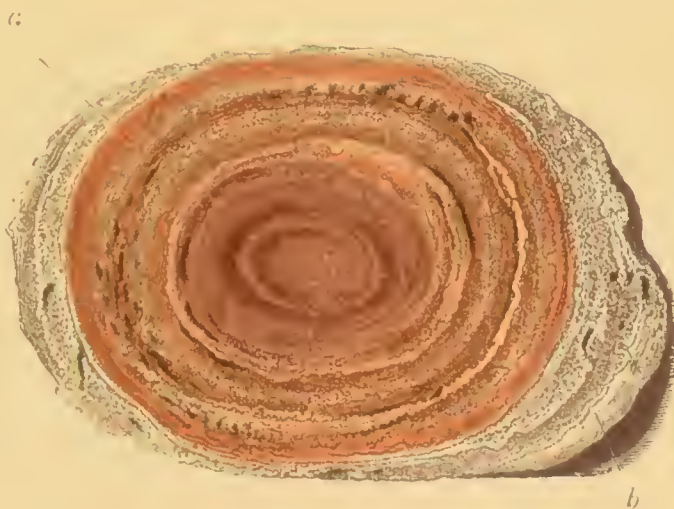




FIG. IV.



FIG. V.

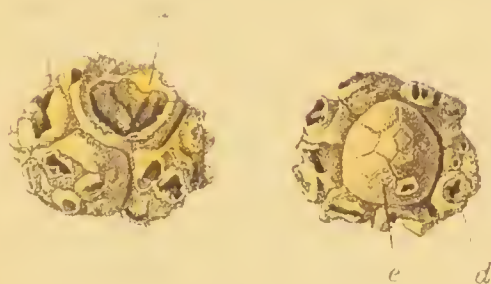


FIG VI.



FIG. VII.





FIG. VIII.





FIG. IX.





FIG. X.



FIG. XI.



FIG. XII.



FIG. XIII.





FIG. XIV.

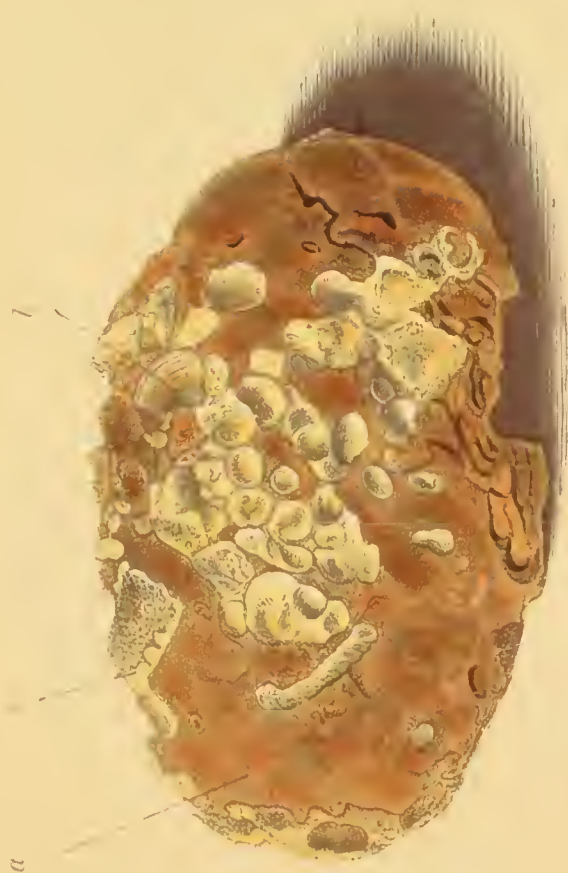


FIG. XV.

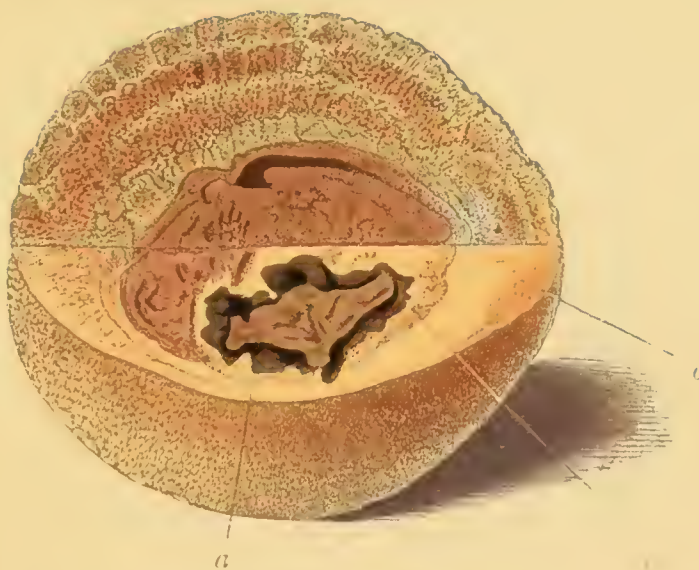


FIG. XVI.



FIG. XVII.



FIG. XVIII.



FIG. XIX.



FIG. XX.

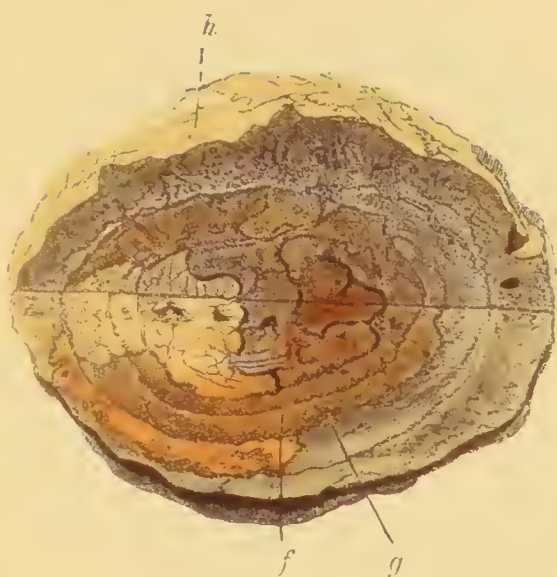


FIG. XXI.



FIG. XXII.



FIG. XXIII.



FIG. XXIV.



FIG. XXV.

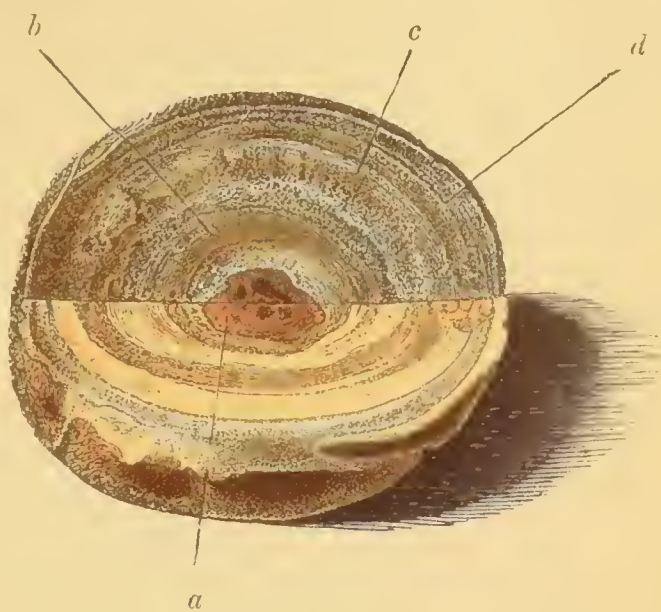


FIG. XXVI.



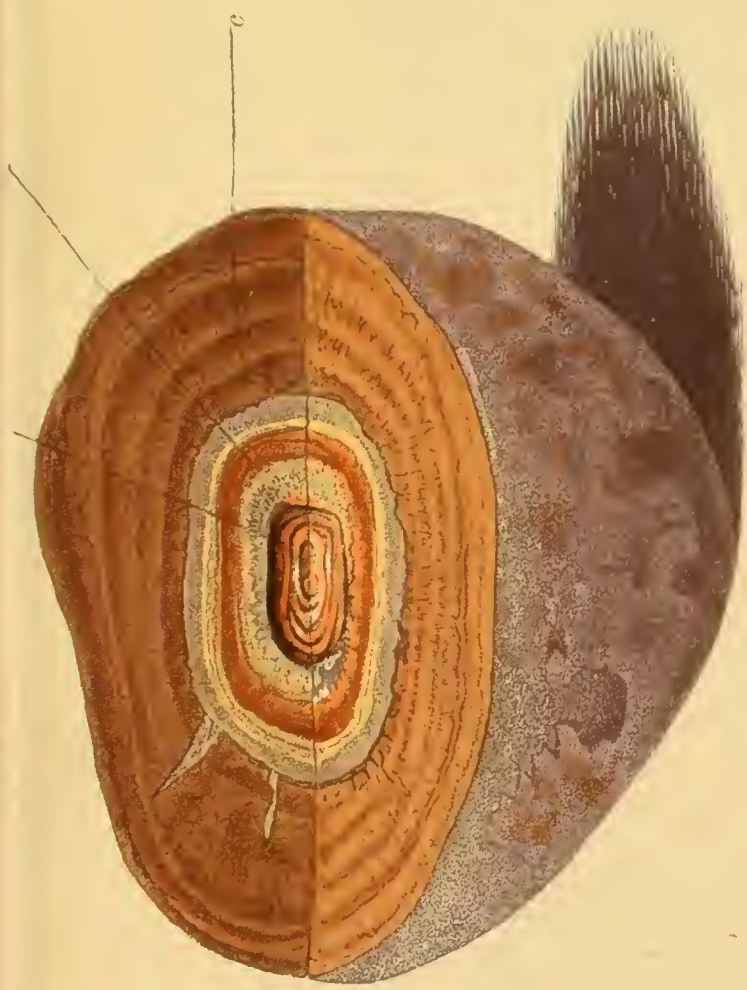


FIG. XXVIII.

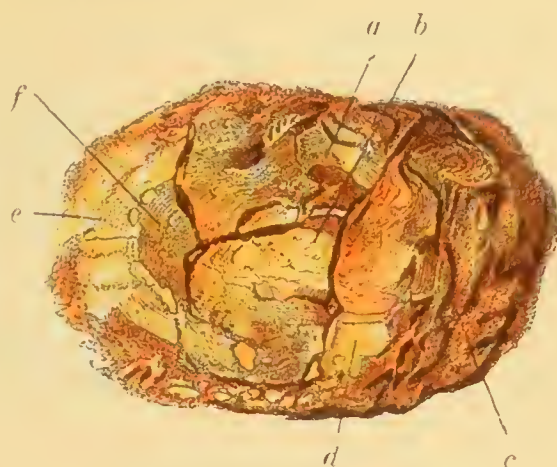


FIG. XXIX.



FIG. XXX.



FIG. XXXI.



FIG. XXXII.



FIG. XXXIII.

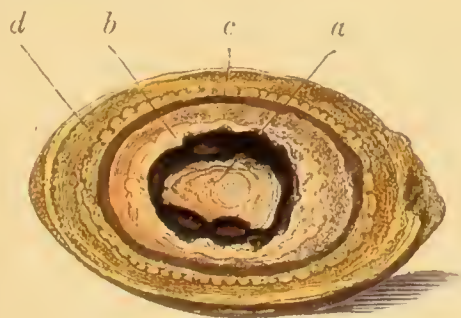


FIG. XXXIV.



FIG. XXXV.



FIG. XXXVI.

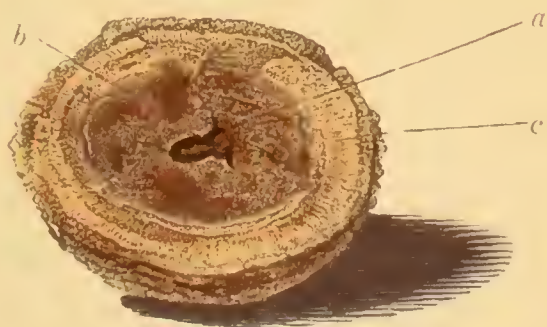


FIG. XXXVII.

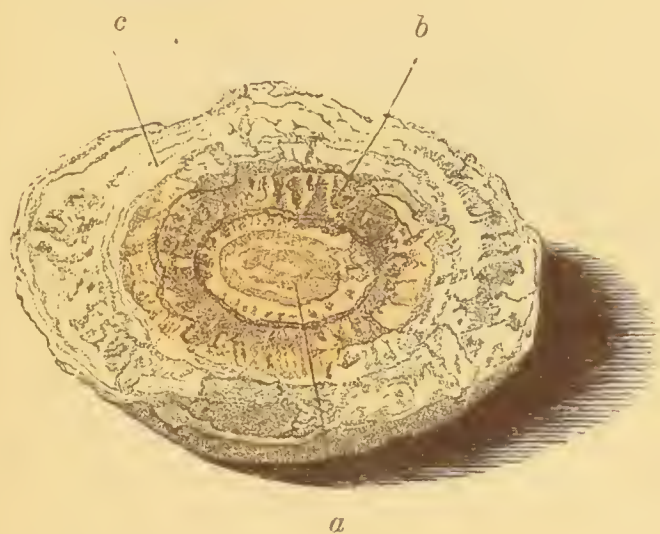


FIG. XXXVIII.

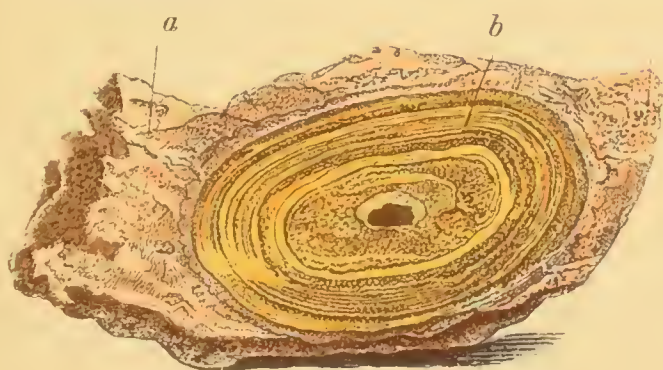


FIG. XXXIX.

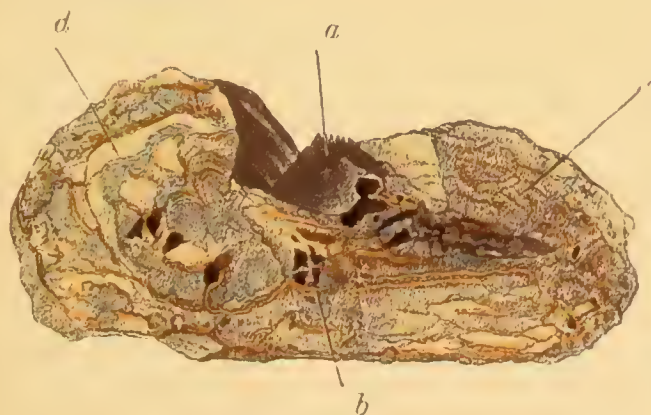


FIG. XL.



FIG. XLI.

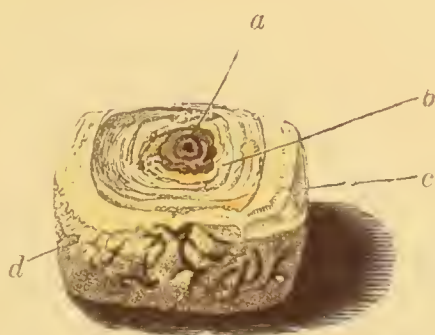


FIG. XLII.

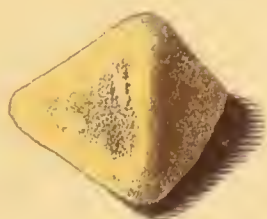


FIG. XLIII.



FIG. XLIV.



FIG. XLV.



FIG. XLVI.

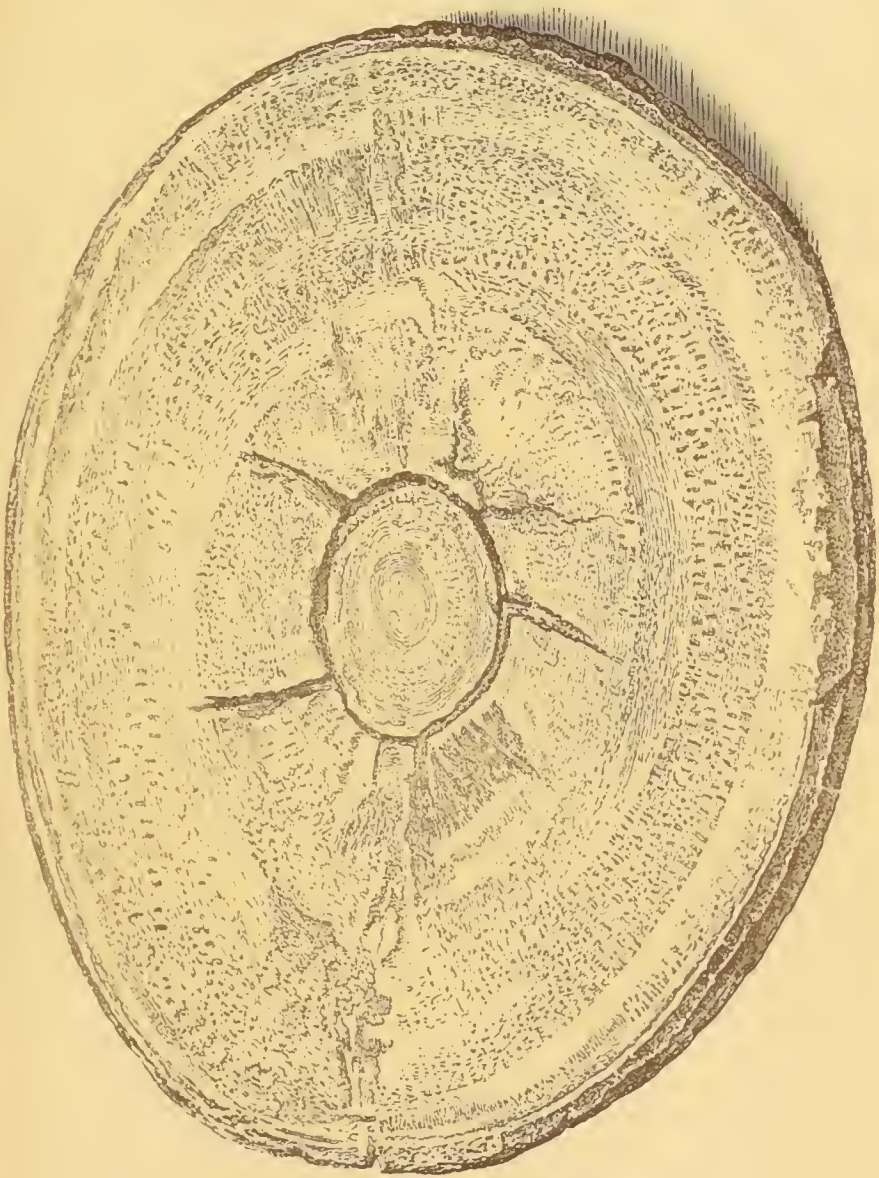


FIG. XLVII.



FIG. XLVIII.



FIG. XLIX.



FIG. I.



INTRODUCTION.

It may readily be conceived, that the sufferings arising from the presence of calculi in the human bladder, should early have attracted attention to the nature and origin of these concretions; and have called forth the numerous dissertations on the symptoms and treatment of calculous disorders, which are to be found in the works of the older medical writers. It was not, however, until the fourteenth or fifteenth century, when chemistry began to be cultivated on something approaching to rational principles, that any advance was made in our knowledge on these subjects.

Valentine first promulgated the idea, that cal-

culi are formed from urine, as tartar is deposited from wine. Paracelsus adopted the same notion, and, among other experiments, by subjecting urinary calculi to destructive distillation, obtained a yellow crystalline mass, to which he gave the appellation of *duelech*.

It was not, however, until Scheele's more philosophical investigations were made public, that the opinion as to the inorganic nature of these concretions was abandoned. From a passage in the preface to Scheele's works, in which he gives a description of the calculi he had examined, it is to be inferred, that he was not acquainted with more than one variety of urinary calculus: for he states, that all those he had met with, were soluble in caustic potash, and convertible into a red substance, by the action of nitric acid.

Bergmann, who repeated and confirmed these experiments, also noticed that a pink colour was imparted to the cuticle, as well as to glass and porcelain vessels, in which a nitric acid solution of this species of calculus had been evaporated. He likewise observed, that when certain calculi

are thoroughly incinerated, the residuum is found to contain a small quantity of lime. A similar effect was obtained, by evaporating the before-mentioned solution to dryness ; but he recommends, that the acid used in these experiments should not be too strong. In his works, published some time afterwards, he alludes to his having discovered oxalic acid in certain specimens of calculus.*

Scopoli, in 1787, in his attempts to detect lime in calculous concretions, met with an acid, which he considered to be oxalic. He, therefore, with Bernouilli and others, enumerated this acid among the usual constituents of calculi ; and in consequence, strongly deprecated the use of sugar in calculous cases ; advising that all substances containing it, and convertible into oxalic, or, as it was then called, saccharic acid, should be avoided. It is more than probable, nevertheless, that the oxalic acid he

* From his detection both of lime and oxalic acid, it may be presumed, that he had met with the mulberry calculus, without recognising it as a distinct variety.

speaks of, was produced by the decomposition of uric acid; owing to his using nitric acid more concentrated than Bergmann had recommended.

Hartenkeil and Margraf verified the discoveries of Scheele and Bergmann; and in 1786, Tychsen, professor of chemistry in the Surgical Academy of Copenhagen, found that a portion of calculus, given to him for examination by Winslow, consisted of lime, combined with phosphoric acid. From the nature of his investigation, and its results, he became convinced, that the calculi examined by Scheele, Bergmann, Archard, Margraf, and others, were entirely different from that which he himself had analysed.

Link, in 1788, published a treatise on the composition of urine, and its morbid deposits; in which, after glancing at previous discoveries, he arranges calculi under two heads:—viz. those composed chiefly of lime, and those containing no vestige of it.

An extensive series of experiments, on the composition of human calculi, and those of the in-

ferior animals, was published by Fourcroy, in the "Annales de Chimie," for 1793; he therein confirmed the truth of Scheele and Bergmann's experiments, but stated that, besides the ingredients already enumerated, human calculi contained ammonia and soda, combined with phosphoric acid.

In 1797, a paper by Wollaston, was read before the Royal Society; no less remarkable for the lucid nature of his experiments, than for the soundness of the principles deduced from them.

Wollaston proposed that urinary calculi should be arranged in five distinct classes: 1st. Calculi of uric acid. 2nd. Calculi of ammonio-magnesian phosphate. 3rd. Calculi of neutral phosphate of lime. 4th. Calculi of phosphate of lime with ammonio-magnesian phosphate, called by him the fusible variety. 5th. Calculi of oxalate of lime, constituting the so called mulberry species.

Notwithstanding its intrinsic excellence, this treatise was for a time neglected; neither Pearson nor Fourcroy took any notice of it, nor did

Scherer mention it, in his "Chemical Journal," until the year 1800; although Pearson's Essay, which appeared the same year as Wollaston's, had been published, two years before, in the above-mentioned journal.

Fourcroy and Vauquelin, in the mean time, continued their researches extensively; having analysed no less than six hundred different calculi. The former subsequently published his "System of Chemistry," in which he enumerates and describes seven different calculous constituents; including those already mentioned by Wollaston, with the addition to the list, of urate of ammonia, silica, and animal matter. The discovery of these, Fourcroy appropriates to Vauquelin and himself, without the slightest allusion to Wollaston. But, as he does not hesitate to mention Pearson's essay, it is probable, as Berzelius remarks, that his silence proceeded from not being aware of Wollaston's prior claim, rather than from any unwillingness to acknowledge it.

A considerable section of Fourcroy's work is occupied with suggestions for the dissolution of

calculus, by means of chemical agents injected into the bladder. This interesting question was afterwards taken up by a multitude of writers, and the subject of chemical solvents was freely and extensively discussed.

Pearson, although he had examined upwards of two hundred calculi, contributed nothing of importance to the facts already known. He gave, it is true, a tolerably exact account of the labours of his predecessors; and also hazarded an opinion, that what Scheele considered to be an acid, was nothing more than a peculiar animal oxide, with very feeble acid properties.

In the year 1801, Proust observed that carbonate of lime was detectable in a great number of calculi; and that he himself had procured it abundantly, from those of the mulberry variety.* Prout, Reuss, and Geiger, however, proved its existence, in the state of carbonate, in human calculi. The latter successfully contradicted

* The carbonate of lime, thus obtained, resulted, in all probability, from the incineration of the oxalate, and the conversion of its oxalic into carbonic acid.

the statement, that oxalate of lime never forms the nucleus of calculous secretions.

In the Philosophical Transactions, for 1810, Wollaston announced the discovery of a new and peculiar variety of calculus, which he denominated cystic oxide. A few years afterwards, Marcet laid claim to the detection of two other varieties, viz. the xanthic oxide, and the fibrinous, both of which he gave an account of in his famous Essay on Calculous Disorders. To this work he annexed tables of the comparative frequency of the different forms of calculus in various collections. Brande had previously published on the same subject, and the example was followed by Henry : so that a great number of authentic data, illustrative of the pathology of these affections, were given to the public.

Soon afterwards appeared Prout's invaluable "Inquiry into the Nature and Treatment of Diabetes, Calculus," &c., in which he not only describes the chemical characters of urinary deposits and concretions, but explains the order in which precipitation takes place.

This work induced many careful observers to follow up the subject, and led to the publication of a great number of accurately conducted analyses; whereby ingredients already recognised were more carefully examined; and others, which had escaped observation, were detected. Wurtzer and Fromhertz recognised oxide of iron in the residua of certain calculi; Lindbergson discovered urate of soda; Bley, carbonate of magnesia; Brugnatelli, benzoate of ammonia.

But, among the essays and treatises which appeared about this period, none is more important than Magendie's "*Recherches sur les Causes de la Gravelle.*" In this essay he directs attention, especially, to the formation of the nucleus, and the causes which determine deposition on this particular centre. It must be conceded, although his ideas are not generally adopted, that his account of urinary deposits, and the suggestions he throws out as to treatment, where operation is inadmissible, are very valuable.

After Marcet's discovery of xanthic oxide,

Stromeyer, shortly before his death, having obtained a calculus of this kind from Langenbeck, who had extracted it from the bladder of a peasant boy, eight years of age; undertook its examination. After the lapse of some years, Liebig and Wöhler, in order to determine as nearly as possible the elementary composition of this singular substance, submitted a portion of this identical calculus to another and more rigid analysis. These eminent chemists confirmed the truth of Stromeyer's researches, and, furthermore, ascertained that it differed from uric acid, inasmuch as it contained one atom less oxygen; it was therefore named uric oxide. In the course of their examinations, many curious facts were elicited as to the ultimate composition of uric acid, its conversion into other principles, and its chemical relations to various animal products.

From the preceding historical sketch, it will be manifest that the labours of the physician have contributed very largely to the advancement of the chemistry of calculous concretions.

Nor can this be matter of surprise, for although mechanical means were at the commencement resorted to, their insufficiency in some cases, and the danger incurred in others, induced persons to endeavour to discover other methods for relieving the sufferings of those, who either could not, or would not submit to operation. Experience had taught, that a certain amount of relief was often attainable from the use of internal medicines; but none could be depended on, so long as no fixed principles existed for their administration; that is, until the real nature of the offending concretion was ascertained.

As soon, however, as Scheele, Fourcroy, and their successors, had promulgated their experiments on the chemical composition of calculi; and had demonstrated the practicability of dissolving them out of the body, a rational expectation was entertained of acting upon them, by chemical means in the bladder likewise; so as, if not to dissolve them, at least to check the rapidity of their growth.

As calculi, however, are not all of the same

composition, before having recourse to chemical agents, it becomes imperative to ascertain this point thoroughly; but as opportunities for acquiring such information are not always afforded, it is desirable that all the means for discrimination, which can be devised, should be resorted to.*

With respect to the recognition of calculus out of the body, it frequently happens that we have

* In some cases, lithotrity comes very seasonably and effectually to our aid, as a means of discriminating the nature of vesical calculus. At a recent *seance* of the "Academie des Sciences," it was decreed, that when once a stone was seized, nothing remained but to crush it, and complete the cure; that, therefore, lithotrity was not available as a diagnostic. I would, however, humbly suggest, that as the cure cannot *always* be achieved at one sitting, we may, during the interval between this, and the succeeding attempt, arrive at a distinct knowledge of the composition of the calculus. I have every reason to believe that solvents used at this stage will contribute not a little to the success of lithotrity; whilst the information acquired from its use will determine, on just principles, the selection of the agent intended to act on the detritus. The use of the crushing forceps with this view, is nothing more than the *exploration* which is generally premised.

no opportunity of making a chemical examination of the fragments that may be voided. We must trust to inspection alone for information as to its composition ; it is desirable, therefore, to be as conversant with the sensible qualities of human calculi, as the mineralogist is with those of the ores submitted to him for examination.

It will not be irrelevant, then, in the following pages to give some details respecting the physical characters of this kind of concretion ; as well to afford the power of recognising them, as to suggest prompt and ready means for applying with effect any chemical test that may be within reach, when more elaborate analysis is not attainable.

ON THE
DISCRIMINATION OF CALCULI.

PHYSICAL CHARACTERS OF CALCULI.

Form.—The most common forms of vesical calculi are the spherical, oblong, and the amygdaloid, but somewhat compressed laterally, so as to give them the shape of pebbles:—See Figs. 2 and 33. They are also ovoid, as in Figs. 18 and 46.

Calculi with deeply tuberculated and rugged surfaces are generally of the same admeasurement in all their diameters; see Figs. 19, 34, 35: and those which are of large size usually have

a reniform or pyriform appearance, as in Figs. 8, and 9. Many specimens are irregularly shaped, in consequence of the increment taking place more on one side, or at one extremity, than the other, as is represented in Figs. 4, and 38. When more calculi than one are present in the bladder, they are generally dissimilar in form, their surfaces being worn away into various facettes, by mutual attrition:—see Figs. 12, 22, &c. The same cause operates also, when they are numerous, in effacing tubercles and natural asperities, and in giving them smooth and even polished surfaces. They occasionally assume the cubical, cuboidal, and tetrahedral forms, but seldom the cylindrical:—see Figs. 41 and 42. The engravings, however, will give a more correct idea of the general outline of these concretions, than any further attempt at description.

Size.—Urinary deposits are generally designated as sand or gravel, until they exceed two or three lines in diameter; this definition, however, is arbitrary and uncertain, for, what is con-

sidered gravel by some, is magnified into calculus by others.

Those which are worthy of the name of calculi, vary in size, from that of a pin's-head to that of a turkey's egg, and beyond; some weigh a few grains; others, again, several pounds. More than half of the specimens examined in the museum of the Academy were found to weigh between half an ounce and two ounces.

The circumstances, however, under which calculi are weighed, should always be taken into account, as their density varies at different times. Thus, when recently extracted, they are comparatively heavy, from retaining in their pores a certain quantity of the fluids in which they have been immersed: this, in process of time, evaporates, and their weight consequently diminishes.

The loss of weight often goes on progressively for some time, even for years, as was the case with a calculus, see Fig. 28, noticed by Professor Jacobson.

			oz.	grs.
1832.—July 9,	calculus weighed	2	+	20
10,	“	“	2	+ 12
11,	“	“	2	+ 5
13,	“	“	—	4
17,	“	“	—	8
25,	“	“	—	9
Sept. 1,	“	“	—	16
1833.—Aug. 12,	“	“	—	36
1834.—Aug. 1,	“	“	—	36

Thus, within two days after extraction, it lost 20 grs.; during the first month 29 grs.; in little more than a twelvemonth 56 grs: after which period it does not seem to have diminished in weight.

Specific Gravity.—Fourcroy states that the specific gravity of calculi varies from 1.213, to 1.976. This estimate does not differ materially from that given by Marcet, and agrees generally with my own observations. In one of the calculi examined by me, see Fig. 11, the sp. gr. amounted to 2.014; the remainder ranged within the limits prescribed by Fourcroy.

In order to ascertain with accuracy the specific

gravity, it is necessary to immerse any calculus, which is not recent, in water for some hours, so that the air retained within its interstices may be displaced. With this view, it may also be placed in an air-pump vacuum: some recommend its being boiled in water, but the probability that the calculus may contain ingredients soluble in boiling water, renders this plan objectionable.

Surface.—The surfaces of these concretions are frequently so characteristic of their composition, that mere inspection will often suffice to enable us to recognise the constitution of at least the external layer. Thus the rugged surface of the mulberry calculus is not to be mistaken, see Fig. 21. Some specimens of this variety are, nevertheless, quite smooth, for instance, the hemp-seed calculus.*

* Besides the hemp-seed, Dr. Prout describes a white crystalline oxalate, resembling what mineralogists call “crested sulphate of barytes.”

Fourcroy says, that the external surface does not indicate the internal constitution, when the size of the specimen exceeds that of a pigeon's egg.

The surface of the ammonio-magnesian phosphate is often rendered irregular by the formation of large foliaceous crystals; whilst that of the phosphate of lime calculus is usually of a porcelaineous smoothness. Uric acid calculi are either smooth and even as to surface, or finely tuberculated, the tubercles not bearing any resemblance to the asperities of the mulberry calculus.

It requires, however, very great discrimination to ascertain the chemical character of a calculus from viewing it externally; there are modifications which often baffle the most experienced. Thus the surface of an uric acid or a mulberry calculus is often covered with a whitish powder, giving it all the appearance of a phosphate or an urate. Several calculi, naturally rough when existing together in the bladder, so polish each other's surfaces as to alter the external characters of all. Sometimes, also, the surface of a calculus is intersected by deep fissures, which are often filled with ingredients of a totally different quality, deposited by the urine; they may likewise contain portions of membrane, derived from the

abrasion of the inner coat of the bladder. These fissures may even contain extraneous materials. See Figs. 13, 14, 17, 18, 19, and 28.

One of the greatest sources of fallacy, however, in judging from inspection alone, arises from the circumstance that the cortex, the body and the nucleus, may all be formed of different materials: see Figs. 8, 9, 14, 23, 34, 35, and 41.

Colour.—Among the external features of calculous concretions, none are more distinctive than that under consideration.

Each of the three prevailing species appears to have adopted its own peculiar livery; but even here, variations in the admixture of ingredients will produce such blendings of the different hues, that it requires a very experienced and practised eye to obtain correct evidence of the composition, even of the external crust, from colour alone.

The colours, however, which are pretty constantly found associated with the different groups are the following. 1st. A tawny-yellow, or fawn colour, running through various shades into a red-

dish brown, indicates the uric acid series, including the cystic oxide variety.* 2nd. The oxalate of lime formation is denoted by its dull purple colour, inclining to brownish black. 3rd. The phosphates and carbonates are either purely white, or partake of a pale yellow or buff tint; but never, except from the admixture of other ingredients, do they become deeper coloured.

A mixture of urate and oxalate of lime is deeper coloured than each principle separately; but the oxalate alone is occasionally so light-coloured, as to assimilate very closely with the greyish hue of the urate of ammonia. The urates of soda and potash vary in colour from uric acid merely in depth of tint; they are very liable to be mistaken for each other.

These observations, it ought to be remembered, relate to the colour of the external surface alone; if the examination be extended by dissecting the concretion, each of the different divisions,—each

* Only when the specimen is recent, for, as Dr. Golding Bird observes, it undergoes a remarkable change in colour, from brown to grey, or rich bluish green, by long keeping.—*Guy's Hospital Reports*, No. xiv.

of the separate laminæ, will be found to differ in colour or in shade, as it varies in the proportion of its ingredients, and in the degree of compactness of its texture. The phosphates, indeed, are exceptions, for, when unalloyed, the white or yellowish tone is preserved throughout the entire surface.

The accompanying engravings, which are faithful representations of the varying tints to be found in calculi, will prove that the task of discrimination is not always an easy one. The colouring may, perhaps, be deemed too vivid ; it is, therefore, proper to mention, that previous to being copied, the specimens were moistened with water, in order to bring out the contrasts more forcibly.

Odour.—Unless calculi are carefully washed after extraction, their odour soon becomes unpleasant, owing to the decomposition of interstitial animal matter, and retained urine ; the tendency to foetor is, however, completely destroyed by ablution in the first instance.

Fourcroy compared the odour of calculi, when

sawn or rasped, to that of bone or ivory; he also considered the spermaceti odour given out by mulberry calculi, thus abraded, as characteristic of the variety.

THE NUCLEUS AND ORDER OF DEPOSITION.

The most important part of a calculus is undoubtedly its nucleus, which may indeed be considered as the original cause of precipitation.* Even when its chemical composition is similar to that of the body and cortex, the nucleus is invariably more dense than the rest of the concretion.

As it is quite impossible to obtain any correct idea of the real composition of a calculus, so long as it remains entire, a section ought to be

* Dr. Bird considers the nucleus of sufficient importance to afford foundation for the system of classification which he adopts; "If ever," says he, "by medical treatment we shall be enabled to prevent the formation of a calculous concretion, or remove one already formed, it will, in all probability, be by means directed by the character of the matter which there is a tendency to deposit as a nucleus."

made as soon as its superficial characters have been sufficiently ascertained. The division should be managed so as to pass through the centre of the nucleus: one of the portions thus obtained must be divided at right angles to the former incision, so as again to bisect the nucleus. These cross sections are necessary, in order to bring the internal structure into view, as the nucleus frequently deviates widely from the geometric centre; see Figs. 8 and 15. They also serve the purpose of exposing the whole of the strata of a laminated calculus, so that the order of succession, and the course each layer pursues, may be observed: if a portion were separated from one side, or from one extremity only, the internal structure, where the layers are thick, might remain as much unexplored as if no section had been made.

Some calculi, on account of their friability, cannot be sawn asunder; as, for instance, the ammonio-magnesian phosphate, and the fusible calculi. Berzelius recommends that the powder resulting from their division should be used for

the purpose of grinding them down to an even surface ; but, in my opinion, the use of a small brush and water is preferable, as being less injurious to the structure, and a saving both of time and trouble.

Whether calculi are sawn asunder or fractured, their internal structure is generally found to consist of concentric lamellæ, arranged around a central mass. Each layer is continuous, and of uniform thickness throughout ; occasionally, however, the continuity of the layers is interrupted ; they either travel out of the direct course, and are lost in the adjacent strata, or terminate abruptly ; the space between the terminal extremities being completed with animal matter. See Figs. 4, 8, 9, 38, and 47.

The facility with which one layer can be separated from the other, depends almost entirely on their chemical composition : those of crystalline formation are readily separable, the amorphous are much more cohesive.

If a calculus is spontaneously fractured, or disintegrated in the bladder, and the fragments

not evacuated, each of them constitutes a nucleus for fresh deposition. When a concretion becomes adherent to the bladder, so that further precipitation can only be partial, the fresh deposits pursue an opposite course to those originally precipitated. In Fig. 29, the two sets of laminæ, *a* and *b*, are seen to pursue opposite directions. Fig. 20 affords another instance of the same fact: the layers *a*, consisting of uric acid, are of primitive formation; the layers *b* subsecutive; while layers *c* are of recent deposition, and form a shell or case, which envelopes the whole. It very seldom happens that the crystalline structure of these concretions is so condensed as to destroy their usual lamellar form.

The nucleus is often formed of foreign bodies, accidentally introduced into the bladder; the deposit around these is generally phosphatic, and their outline often peculiar; see Fig. 40. Pins, needles, tobacco-pipes, fragments of surgical instruments, and other extraneous materials, have been found in the bladder, incrustated with calcareous matter; and Brande states that one calculus which he

examined, consisted of uric acid, coating a hazel nut ; in others the nucleus was a garden pea, a needle, and part of a bougie.

Occasionally two nuclei are found in the same calculus ; see Figs. 26 and 43 : and in some cases even, four of these centres of deposition have been discovered ; see Fig. 40. Others, again, are met with in which a central cavity exists, in the place of a nucleus ; its parietes studded with crystals, derived from the slow evaporation of urine originally included within the cavity. In other cases the space contains a portion of shrivelled animal matter, the remains, probably, of the original nucleus. Henry mentions three cases of the kind.

The most perfect specimen of this modification I have seen, is in the possession of Professor Jacobson. The excavation is not entirely closed, but communicates, by numerous fissures, with the exterior. From the roof and walls of the central chamber, several crystalline tufts project. The calculus seems to be made up of a number of segments, of various figures, round,

square, and pentahedral, agglutinated together at their edges. This singular concretion is represented by the two impressions, Fig. 5.

The collection of the above-mentioned learned Professor contains a great variety of this kind of calculus, taken from different subjects. Forty of these were found loose in the bladder, and sixty were contained in sacculi, formed by the protrusion of its lining membrane between the fibres of the muscular coat.

Two of these I have had opportunities of examining: the one, taken from the bladder itself, was readily fusible, and consisted of phosphate of lime, triple phosphate, and a small proportion of uric acid; the other, which had been en-sacculated, was formed of uric acid, urate of ammonia, and basic phosphate of lime, with a little ammonio-magnesian phosphate.

The collection of the academy contains no perfect specimen of this kind of calculus: I have, nevertheless, found, in one of the compartments, four ounces of fragmental segments, some round, others angular, portions, apparently, of formations similar to the above-mentioned.

In some concretions of this kind, the central mass is composed of large crystals, identical, in composition, with the circumjacent layers.* This variety, however, has most frequently been detected in the inferior animals.

The collection of the veterinary school possesses a very perfect specimen taken from a horse. The central portion contains large free crystals, and is surrounded by a compact layer of the same,—denser strata succeed, all of which, however, are crystalline. The body is formed of fusible, siliceous, and organic materials.

THE CONSTITUENTS OF CALCULI.

Having described the physical characters of vesical calculi, I shall proceed to consider the chemical properties of their principles.

* A drawing and description are given by Dr. Bird, of an uric acid calculus without any nucleus: “a central, well-defined cavity studded with stalactitic nodules, occupies its centre.”—*Guy's Hospital Reports*.

The following is a full enumeration of those which have, up to this period, been detected.

1. Uric acid.
2. Urate of ammonia.
3. ——— soda.
4. ——— potash.
5. ——— lime.
6. ——— magnesia.
7. Xanthic, or uric oxide.
8. Ammonio-magnesian phosphate.
9. Phosphate of lime.
10. Cystic oxide, or cystine.
11. Organic matter.
12. Oxalate of lime.
13. Carbonate of lime.
14. Carbonate of magnesia.
15. Silex.
16. Oxide of iron.
17. Benzoate of ammonia.
18. Oxalate of ammonia.
19. Phosphate of iron.
20. Clay, mica.
21. Hydrochlorate of ammonia.
22. Urea.

Many of these ingredients are constantly present in healthy urine, others are found only in an unhealthy condition of that fluid ; some, again, owe their introduction to accidental causes ; but are no more to be reckoned among the usual constituents of calculi, than the hazel-nuts, peas, and tobacco-pipes mentioned by Brande and others.

Several of the substances enumerated in the accompanying list, as well as their combinations, are sparingly soluble in water, and therefore readily precipitable, under certain conditions of the system, or of particular organs. But, it is difficult to account for the presence of crystals of the more soluble salts in the central cavities of a calculus ; unless by supposing, that these salts are retained in its excavations, at the period of extraction, and gradually crystallize, as the aqueous portion of the fluid dissipates.

URIC ACID.

This highly azotized principle, either alone or combined with various bases, forms a large proportion of the calculous concretions to which man is subject. Its elementary composition is carbon, nitrogen, hydrogen, and oxygen, represented by the following formula. $C_5 N_4 H_4 O_5$.

This acid is found in human urine, as well as in that of several of the inferior animals, especially the carnivorous. When pure, its properties are as follows. It is white, either pulverulent or crystalline,* very sparingly, or scarcely at all, soluble in either cold or hot water; insipid and inodorous; insoluble in alcohol, æther, and oil; soluble in caustic potash, and in concentrated

* The natural form of the crystal, viewed by the microscope, or a Coddington lens, is rhomboid, of a tolerable distinct lozenge shape. There are various modifications of these crystals ably described by Dr. Bird, to whose paper, and to the researches of Vigla, the reader is referred for information on a subject of great interest and importance, as affording a ready and exact means of determining the nature of calculous ingredients.

sulphuric acid. From the latter it is precipitated by the addition of water.

Dilute hydrochloric acid acts on it sparingly :* but nitric acid, even when diluted, not only dissolves, but decomposes it, with the disengagement of nitrogen and carbonic acid gases. Various new compounds are formed by the mutual action of the two acids. Of these, the purple pigment called purpuric acid, is, in a practical sense, the most deserving of notice. It affords certain indications of the presence of uric acid, either free or combined, even when a very small quantity of that principle is present.

The manner in which uric acid is affected by chlorine and hydrochloric acid, has not as yet been sufficiently investigated. Weak solutions of carbonate of potash and sub-borate of soda dissolve it by digestion ; it is again precipitated by a current of carbonic acid gas.

* Liebig says that concentrated hydrochloric acid dissolves rather more of the uric, than pure water ; it is, however, so sparingly soluble in the dilute acid, that the latter is generally used for precipitating it from alkaline solutions.

Uric acid is decomposed by heat, the products varying according to the degree of temperature employed. The results of dry distillation, therefore, are, in the first place, hydrocyanic acid and urea; subsequently hydrocyanic acid, ammonia, and cyanic acid. In both cases a carbonaceous mass remains in the retort.

According to the investigations of Berzelius, one thousand parts of healthy human urine contain only one part of uric acid; nevertheless, as was before mentioned, more than three parts of all calculi are formed of it, either pure or combined with other ingredients.

Calculi of uric acid.—The chemical qualities of this variety of calculus appear to have been more minutely described by Berzelius, than by any other author.

The prevailing colour of the species is a yellowish-fawn, similar to that of wrought oak; passing from this, through every gradation of tint, to a brownish-red, like that of mahogany. Sections of this kind of calculus often bear a striking resemblance to the knots in a red

deal plank, both in point of colour, and the arrangement of the concentric striæ; see Fig. 8. Fig. 7 is an example of the palest specimen in our collection; and the nucleus of Fig. 3 may be cited as an instance of the darkest.

The external surface is either smooth, or finely tuberculated; the tubercles themselves being smooth. The cut surface exhibits a regular series of concentric laminae, parallel to the outline of the section. These laminae are of different densities, so that, between the compact layers immediately surrounding the nucleus, and those which form the external crust, layers of a more or less loose and porous texture are often interposed. See Figs. 2, 4, 30, 32, and 38.

The fractured surface is compact and crystalline, never amorphous when unalloyed. The specific gravity is from 1.500 to 1.786, in this respect, intermediate between the earthy phosphate and the mulberry variety. Even when free from the admixture of other ingredients, it generally contains some portion of albumen, vesical mucus, and colouring matter of the

urine. The latter is to a certain degree soluble in acetic acid, to which it imparts a yellowish tinge.

Berzelius says, that it is difficult to determine whether the animal matter contained in these calculi consists of albumen or vesical mucus. For, when a portion of the concretion, dissolved in caustic potash, is precipitated by hydrochloric acid, on washing the precipitate, and adding to the liquid that portion of water which first passes the filter, a fresh deposit is produced. If the water used in washing be collected apart, and tested with hydrochloric acid, the precipitate which forms, behaves precisely like a neutral combination of albumen or fibrin with hydrochloric acid, when its watery solution is precipitated by ferro-cyanate of potash. Now, as the same reaction takes place, on treating vesical mucus in a similar way, he thinks, that the animal matter is combined with uric acid in a manner analogous to that in which mucus combines with hydrochloric. In short, that they are chemically and not mechanically combined.

Almost all calculi of uric acid yield, on incineration, a minute residuum, containing potash, soda, or lime; occasionally phosphate of lime, and even silica.

Chemical characters.—Uric acid calculus powdered and boiled in a solution of caustic potash, readily dissolves. It is also soluble, though by no means readily, in the alkaline carbonates; this difference in the mode of action of the two menstrua, serves to distinguish uric acid from urate of ammonia.

From the solution in pure potash, it is precipitable by hydrochloric or acetic acids, in the form of a white gelatinous deposit, which soon becomes granular, and ultimately crystallizes. These acids also dissolve any of the earthy or alkaline salts which the potash has refused to dissolve.

When nitric acid, diluted with about thrice its bulk of water, is added to the powdered calculus, decomposition, and solution with effervescence, take place, a yellowish liquid results, containing impurities: such as animal matter, &c. The

filtered fluid, on slow evaporation in a glass, porcelain, or platinum capsule, leaves a pink stain, which is deepened into a rich purple on adding a drop or two of liquid ammonia. If the heat employed be too great, or the nitric acid too much concentrated, a yellow, instead of a pink stain is produced, which remains unchanged by ammonia.

Professor Jacobson recommends, that the solution in nitric acid should be merely inspissated, not dried; and that the capsule containing it should be inverted over a vessel containing a small quantity of ammonia, the vapour of which will convert the pink into the purple colour, so distinctive of the presence even of the smallest proportion of uric acid.

In order to determine the existence of any other ingredient in the calculus, Berzelius directs that a small fragment should be submitted to the action of the blowpipe, on charcoal or platinum, at first to the outer or oxidizing flame. At the commencement, an odour of burnt horn exhales; as the mass consumes, it gives off the smell of

hydrocyanic acid : finally, it inflames, and blazes vividly for a short time, then remains incandescent, even after the current from the blowpipe ceases to be urged.

When the uric acid is unalloyed, scarcely a vestige of ash is obtained ; it is nevertheless alkaline, and soluble in water. If, however, there is a palpable residuum, insoluble in water and not alkaline, phosphate of lime is likely to have been present.

An alkaline residuum, insoluble in water, and effervescing with acids, indicates the previous existence of oxalate of lime ; which by heating is first converted into carbonate, and then, if the temperature be much urged, into caustic lime.

A residuum very alkaline, readily soluble in water,* and effervescent with acids, denotes that urates of soda or potash were present, which have been converted into carbonates by heat.

Those who have not acquired the management

* The solubility of the one residuum in water, and the insolubility of the other, distinguish the oxalates, from the urates with fixed bases.

of the blowpipe, may perform these experiments by heating the assay on platinum foil with Berzelius' lamp.

THE URATES.

Urate of Potash.—This salt, when uncombined, is soluble in 480 parts of cold water; much more so, however, in boiling water, the solvent power of which is still further increased by the super-addition of a small quantity of caustic potash; if too much be added, the effect on the urate is decreased.*

Urate of Soda.—Is similar, in most of its properties, to the former salt. Although rarely found in considerable quantity in urinary cal-

* Dr. Venables gives two forms of blowpipe analysis for the discrimination of potash. 1st. Harkort's, which consists in fusing pure oxide of nickel into a glass with borax; if to this, any substance containing potash be added, the glass is coloured blue. 2nd. Fuch's fuses a portion of the assay on a loop of platinum wire, and when the point of the inner flame is directed upon it, the outer flame acquires a decided violet tint. Soda communicates a yellow colour to the flame.

culi, it forms the chief ingredient in gouty concretions.* The following is the analysis of a calculus containing a certain proportion of this ingredient. It was examined by Lindbergson.

Urate of soda	.	.	.	.	9.77
Subphosphate of lime	.	.	.	.	34.74
Triple phosphate	.	.	.	.	38.35
Carbonate of lime	.	.	.	.	3.14
Carbonate of magnesia	.	.	.	.	2.55
Albumen	.	.	.	.	6.87
Water, and loss	.	.	.	.	4.53
					<hr/> 100. <hr/>

Urate of Ammonia.—This principle has the same degree of solubility in water, and is in many other respects similar to the urates with fixed bases; it possesses, however, characters which tend readily to distinguish it from them. The application of heat, for instance, dissipates the urate of ammonia entirely; whilst the urates of

* Before the blowpipe these concretions blacken, and when they inflame, yield an animal fætor. A black and very alkaline residuum is left, which may be fused into a transparent glass with silica. If earthy salts are present, the glass bead is rendered opaque, and assumes a white or grey colour.

potash and soda, treated in the same manner, leave a distinct residuum.

Prout says, that urate of ammonia is much more soluble in water, than the alkaline salts; but this is rendered doubtful by the fact, that the addition of ammonia in excess diminishes the solvent power of the fluid, whereas potash increases it.

We have but one specimen in the museum, consisting solely of this constituent. It is reported to have been taken from the bladder of a girl, which is in favour of the opinion, that this kind of calculus is almost entirely confined to young subjects.

The urate of ammonia calculus is rarely of large size; its surface is for the most part smooth, not unfrequently tuberculated, and occasionally studded with sharp crystals of triple phosphate. It is of a pale slate-colour, inclining to yellow. The cut surface consists of layers thinner than the uric acid variety, and not so well defined; it presents a deeper shade of colour than the external superficies, the tint being precisely similar to what

is called "wood-brown." Its fracture, though compact, is earthy ; when uric acid is also present, which often happens, the fracture is more granular or arenaceous, and the colour more inclined to grey.

This ingredient is almost entirely soluble when powdered and boiled in a sufficient quantity of water ; the saturated solution, on cooling, deposits a white amorphous mass. If to the above aqueous solution, after refrigeration and decantation, hydrochloric acid is added, the uric acid is precipitated ; caustic potash added to the filtered liquid, causes the evolution of ammonia in abundance. This mode of detecting the presence of ammonia ensures its being the product of the urate ; whereas, when a fragment is heated with caustic potash, the result cannot be relied on ; for the disengagement of ammonia may have depended upon the decomposition of triple phosphate crystals, which, as has been stated, occasionally adhere to the surface of these calculi.*

* The presence of earthy salts is determined by a portion of the powder remaining undissolved, even when an excess of boiling water has been used.

When hydrochloric acid is dropped into a warm aqueous solution of urate of ammonia, precipitation does not immediately take place ; but, on cooling, beautiful needle-shaped crystals gradually form.* By these characters, it is easy to recognize this salt even when in combination ; and, although it yields the peculiar uric acid reaction, yet its solubility in water, its more ready solubility in the carbonated than the caustic alkalies, and other properties, serve to distinguish it from the calculus of uric acid

Urate of Lime.—This urate, although less soluble in water than the preceding, is, nevertheless, much more so than hydrate of lime ; for lime-water retains its transparency, even after being saturated with uric acid.

Lime combines in more than one proportion with uric acid : thus, when to the neutral urate, hydrochloric acid is added, a bi-urate of lime sub-

* Dr. Bird recommends that a drop or two of the clear fluid, after being evaporated, should be placed under the microscope ; the crystallised tufts and feathers of hydrochlorate of ammonia will attest the presence of ammonia ; and if soda was present, minute cubes of chloride of sodium will be detected.

sides. The urate is found occasionally combined with fusible matter; the separation of its uric acid is effected, by boiling the fragment in a solution of caustic potash; on adding hydrochloric acid in excess after filtration, the uric acid is precipitated.

Urate of lime is often found in combination with the oxalate, but, as a principal constituent of calculus, it is rare. The museum contains a stone composed of the urates of lime and ammonia, with a thin crust of phosphate of lime. This specimen is very hard, has a shining fracture, and in colour resembles that of an unburnt coffee berry. By boiling a fragment in water, I found that the urate of ammonia was dissolved; on adding more water and continuing the ebullition, urate of lime was also dissolved. When a fragment was heated in dilute hydrochloric acid, uric acid subsided on cooling; and the filtered solution, treated with ammonia or potash, yielded a slight precipitate of phosphate of lime. The addition of oxalate of ammonia, to the clear solution nearly neutralized with liquid ammonia, caused the greater part of the lime to precipitate.

When urate and oxalate of lime are combined, their separation is conveniently effected by digesting the powdered calculus in a large proportion of dilute hydrochloric acid, which dissolves the oxalate alone and unchanged; the uric acid precipitates, whilst the lime with which it was united, combines with the excess of hydrochloric acid. The liquid must be filtered to get rid of the uric acid; and on saturating the clear fluid with ammonia, oxalate of lime is precipitated. The rest of the lime resulting from the decomposed urate, will subside on the addition of oxalate of ammonia.

Urate of Magnesia.—This is a salt rarely met with as a principal constituent of calculi, owing, either to the small quantity contained in the urine, or to the great solubility of the magnesian urates.* For the latter reason, magnesia has

* Berzelius says, that when a hot saturated solution of urate of potash is mixed with a solution of any of the earthy salts, a precipitate will take place; but much more slowly where magnesia is present, because the magnesian is the most soluble of the earthy urates.

been frequently recommended, in preference to alkaline medicine, in the acid diatheses.

Starke has in his possession a calculus containing a large quantity of this ingredient. In figure and size it is like half a walnut ; its surface is of a bright purple, and strewed with a number of minute crystals. The nucleus is composed of uric acid and urate of ammonia ; the latter deposited in layers which are surrounded by others of an ash colour, containing a small quantity of the phosphates, combined with urate of magnesia ; the latter salt forms the external crust almost entirely.

I had an opportunity of making a chemical examination of the calculus just described ; and found that the greater portion of the phosphatic salts and uric acid were insoluble when boiled in water, which fluid, however, dissolved the urates. Hydrochloric acid was added to the filtered solution until the whole of the uric acid subsided. Caustic potash being added to the limpid fluid and heated, a white precipitate was formed, rea-

dily soluble in sulphuric acid, but not so readily in hydrochlorate of ammonia.*

Urate of magnesia has also been detected in two calculi in Christensen's collection. The larger of these, see Fig. 41, is cubical, its surface is studded with crystals of fusible matter, *c. d.* The nucleus *a*, and some of the layers *b*, surrounding it, are composed of uric acid, with urates of magnesia and ammonia. The lesser calculus, which is tetrahedral, as represented by

* Rose says, that sulphuric acid produces no precipitate in concentrated solutions of the magnesian salts; that a solution of potash causes a voluminous flocculent deposit; and a solution of muriate of ammonia added to that of magnesia, renders the subsequent addition of potash productive of a slighter precipitate.

Berzelius, alluding to Scharling's examination of the above calculi, states that, from the aqueous solution of the urates of magnesia and ammonia, hydrochloric acid precipitates the uric acid. The supernatant fluid, he says, must be evaporated to dryness, moistened with hydrochloric acid and again evaporated. The addition of absolute alcohol dissolves the chloride of magnesium, and leaves hydrochlorate of ammonia undissolved. From the alcoholic solution magnesia is precipitated by carbonate of potash; the precipitate is heated to redness to drive off the carbonic acid, and on adding water, potash is dissolved and pure magnesia remains.

Fig. 42, contains a greater proportion of the urates.

Wishing to ascertain, whether the magnesia, which had been precipitated in the former examination, might not have proceeded from the fusible material, I instituted the following experiments. Five grains of the before-mentioned calculus, and an equal quantity of triple phosphate, were separately boiled in half an ounce of water : to these fluids, filtered after cooling, a little acetic acid was added. From the former solution, uric acid was precipitated, and on adding potash, magnesia also subsided ; the latter solution yielded scarcely any precipitate, because the magnesia of the phosphate was not separated.

XANTHIC OR URIC OXIDE.

This substance has very rarely been found as the sole constituent of urinary concretion, although it is said to be of frequent occurrence, combined with other ingredients. Its real nature was a matter of uncertainty, until Wöhler and

Liebig confirmed what had been advanced by Marcet and Stromeyer; and ascertained, by a careful elementary analysis, that it consisted of the same base as uric acid, united with one atom less oxygen. They therefore gave it the more appropriate and distinctive name of uric oxide.*

The following formulæ will show the slight difference in the composition of the two substances.

Uric oxide.

C^5

N_4

H_4

O_2

Uric acid.

C_5

N_4

H_4

O_3

The before-mentioned celebrated chemists undertook the examination of the identical calculus

* Berzelius calls it urous acid, so that this rare substance, of which so few grains are known to exist, enjoys the distinction, or rather confusion, of three names, viz., xanthic oxide, uric oxide, and urous or ureous acid.

Before the blowpipe it decrepitates *slightly*, splits into small fragments, blackens and ultimately consumes, leaving a small quantity of white ash. The odour it gives out differs from that of uric acid and cystine.

which Stromeyer had, some time before, declared to be xanthic oxide.

The weight of the fragment examined by them was eleven *grammes*.* Its surface was partly smooth, brown and polished; partly white or flesh-coloured, and earthy: its fractured surface was of a reddish-brown, or cinnamon colour. It consisted of concentric lamellæ, easily separable from each other, but it was neither crystalline nor fibrous in structure. The cut surface when rubbed assumed a waxy or resinous lustre.

Its characteristic properties were solubility in warm nitric acid, without the evolution of any gas; and the formation of a yellow, instead of a pink stain, on the cautious evaporation of the solution; the nature of the yellow or lemon-coloured residue was not ascertained; it dissolved, however, in water, to which it imparted its own hue, and was also soluble in potash, which it tinged with a darker shade of yellow.

The discrepancies between this description and that given by Marcet, arise most probably, from

* One *gramme* is equal to about fifteen and a half of our grains.

the specimen examined by the latter having contained an admixture of uric acid.

To render the analysis more complete, they dissolved another portion of this rare calculus in caustic potash; to this solution a brownish colour was communicated, with a shade of green, resembling that of bile; the solution lost its transparency, and acquired a viscosity which rendered its filtration through paper difficult. A stream of carbonic acid gas was transmitted through it, until the potash was converted into bicarbonate; when the whole of the xanthic oxide subsided in the form of a white powder. This precipitate, after being washed, was found to retain no vestige of the presence of potash; in this respect, differing from uric acid, which under similar treatment, is precipitated as urate of potash, but never uncombined.

Xanthic oxide is, also, more soluble than uric acid in caustic ammonia, from which it separates, in the shape of a yellow foliaceous residue, retaining traces of ammonia: it is soluble also in concentrated sulphuric acid, but is not, like uric acid, precipitated by the addition of water. It is

likewise soluble in hydrochloric and oxalic acids, and in these respects, differs from cytic oxide.

Submitted to destructive distillation, it resembles uric acid, in affording a considerable quantity of hydrocyanic acid; the empyreumatic odour which exhales resembles that of burnt horn; when sublimed, carbonate of ammonia is formed, but no urea. The museum possesses no specimen of this variety of calculus.*

AMMONIO-MAGNESIAN PHOSPHATE.†

This compound occurs frequently as the external covering of calculi, or interposed between lamellæ of other ingredients; but, it is said to be seldom found as the sole constituent of human

* To recapitulate, it differs from uric acid, in being more slowly soluble in nitric acid; in not effervescing, and not affording the characteristic pink stain; it differs, in not being precipitated by water from its solution in sulphuric acid; in being more soluble in potash and ammonia, and not precipitable by hydrochlorate of ammonia; it differs also in being precipitable from its solution in potash, without combining with the alkali, by carbonic acid.

† Also called triple phosphate and triple salt.

calculi.* Having myself met with a specimen, entirely composed of triple phosphate, I shall give a brief description and a delineation of it; see Fig. 49. When first extracted it was perfectly white, but is now inclining to yellow; its long diameter is one inch, its shorter half-an-inch; it weighs one hundred and twenty grains, is composed of minute irregular shaped crystals, some of which are of a yellow hue, and line a small cavity in its centre.

Triple phosphate frequently forms the principal mass in a calculus, as may be seen in a number of specimens in our collection: Fig. 42, may be considered, in some measure, as a type of the species. Fig. 8, is another specimen of this kind, the surface of which is studded, as is often the case, with large shining crystals.

This species of calculus is white or yellowish,

* Most authors say that all the other diatheses terminate in this, so that, although calculi of the phosphates alone are more rare than others, few nuclei remain long in the bladder, no foreign matters are introduced into it, and the organ itself is seldom organically affected without the deposition of phosphatic salts.

not always lamellar in structure, but occasionally consisting of a mass of brittle crystals, easily separable when recent, and pulverizable when dry. The form of crystal, according to Wollaston, is that of a short trilateral prism, having one right and two equal angles, terminated by a three or six-sided pyramid. The mere inspection of these crystals will generally afford sufficient evidence as to their chemical composition.* The above-mentioned philosopher was the first who demonstrated the presence of this salt in human calculi; Fourcroy and Vauquelin had, however, many years before alluded to it,

* When a fragment of the calculus is dissolved in hydrochloric acid, and a drop placed under the microscope, its nature can be determined by the addition of a single drop of ammonia, which, in this case, precipitates a series of stellar crystals.

The crystals spontaneously deposited from urine, containing the neutral triple salt, are all either prisms or modifications of this form. Those deposited by urine containing the bibasic salt, consist of thin crystalline laminæ, resembling foliage; but when precipitated by ammonia, they assume, as in the case of the calculus, an elegant stellar shape.—*Dr. Bird.*

as an ingredient in the calculi of the inferior animals.

This form of phosphate is very sparingly soluble either in hot or cold water; rather more so, however, in the former. It is readily soluble in dilute hydrochloric, acetic, and other acids; from these solutions it is precipitable by ammonia in a crystalline form, and undecomposed. Heated with a solution of caustic potash, ammonia is expelled; the phosphoric acid combines with the potash, whilst the magnesia subsides as an insoluble residuum. From its solution in hydrochloric acid evaporated to dryness, crystals of hydrochlorate of ammonia form, and may be recognised with the assistance of a lens.*

Dilute sulphuric acid serves to distinguish this salt from the phosphate of lime; the acid dissolves the magnesia and ammonia, but leaves an insoluble sulphate of lime, when that earth is present.

* The crystals in this case assume a plumose arrangement, but are generally octohedral or cubical.—*Bird*.

When a fragment of the calculus is submitted to the blow-pipe, it first of all diminishes in volume, becomes charred, gives off a strong odour of ammonia, swells into a gray carbonaceous cinder, and ultimately fuses, forming a whitish gray enamel.* If moistened with a solution of nitrate of cobalt, and then calcined, a rose-coloured flame is produced, which is indicative of the presence of magnesia; the mass fuses into a vitreous bead of a deep red colour.

TRIPLE PHOSPHATE WITH BASIC PHOSPHATE OF
LIME. †

With the exception of the uric acid, this is the

* With borax and microcosmic salt it melts into a transparent glass, which becomes opalescent on cooling, if the calculous matter is in excess. It fuses with soda, into a white, spongy, scoriaceous mass; but a great preponderance of the flux renders it infusible. Fused with borax into a bead, which is transfixed by a fine steel wire, and again fused in the inner flame, a brittle magnetic phosphuret of iron is formed.

† Called also fusible calculus, mixed phosphate, &c.

most frequent ingredient in the urinary calculi, both of men and other animals.

Marcet attributes its discovery to Tennant, but also states that Wollaston was the first who described its chemical characters. It must not be lost sight of, however, that Tychsen, in 1786, eleven years before the publication of Wollaston's treatise, mentions a calculus, examined by him, which fused readily, but did not consume before the blowpipe; it appeared to consist of ammonia, lime, and phosphoric acid, in addition to other substances.

Several specimens are to be found in our museum, of calculi composed almost entirely of fusible material; see Figs. 39, and 46. It is also frequently found to form the crust or external coating, surrounding nuclei of uric acid, urate of lime, and also of oxalate of lime; see Figs. 8, 9, and 43. Although these concretions are characterised by their fusibility before the blowpipe, it must be remembered that the readiness, or otherwise, with which they melt, de-

pend upon the proportions the different ingredients bear to each other.*

Fusible calculi are quite white, resembling masses of chalk, in this respect, and also in the white powder they deposit on whatever they touch. Their fractured surface is earthy, interspersed with sparkling crystals; and although in general friable, their texture is occasionally compact and dense. When laminated, which is seldom the case, the intervals between the layers are filled with small, distinct, and brilliant crystals, of ammonio-magnesian phosphate.

They frequently acquire a very large size: the specimen of which Fig. 44 is a representation,

* The increase of phosphate of lime beyond a certain quantity, diminishes their fusibility, and a further addition renders them virtually infusible; the preponderance of magnesian salt, although it lessens, does not prevent the disposition to fusion; alone, the calculus fuses into a white bead; with oxide of cobalt the bead is coloured blackish-brown. Before fusion it exhales a very slight quantity of ammonia vapour, which mostly arises from the destruction of animal matter.

weighed as much as fifteen ounces ; another was met with weighing ten ounces and a half.

The triple phosphate is separable from the phosphate of lime, by digesting the calculus in dilute acetic acid. This dissolves the whole of the former salt, leaving as a residuum the greater part of the subphosphate. The carbonates, which are, in greater or less quantity, always associated with this kind of calculus, may also be dissolved and separated by this means : the carbonic acid escapes, and the bases form soluble acetates.

The fusible constituents may likewise be separated, by dissolving the calculus in dilute hydrochloric acid ; then nearly neutralizing the acid with liquid ammonia, and adding oxalate of ammonia from time to time, as long as lime is precipitated. When the whole has subsided, the clear fluid is to be carefully decanted or filtered, and caustic ammonia re-added : after a time a precipitate again takes place, which consists of magnesia.

PHOSPHATE OF LIME.

Dr. Wollaston was the first to detect this salt in the human calculus, and his description is so perfectly applicable to the specimens contained in the museum of the Academy, represented by Figs. 40, and 43, that I shall quote the precise words of this enlightened author.

“ Its surface,” says he, “ is generally of a pale brown, and so smooth as to appear polished. When sawn through, it is found very regularly laminated, and the laminæ in general adhere so slightly to each other, as to separate with ease into concentric crusts. In a specimen with which I was favoured by Dr. Baillie, each lamina is striated in a direction perpendicular to the surface, as from an assemblage of fibres.” The figures above alluded to, distinctly exemplify the structure he describes.

A particle of this kind of calculus powdered, and heated before the blowpipe, becomes

charred ; if the temperature is much raised, the powder at length fuses into a white bead.*

In order to determine the exact composition of this concretion, I undertook the following quantitative analysis. A fragment, weighing 1.018 *gramm.*, of the calculus, Fig. 43, reduced to powder, was dissolved by heat in hydrochloric acid ; on being treated with sulphuric acid and alcohol, the solution yielded a precipitate of sulphate of lime, weighing 1.087 *gramm.* ; equivalent to 1.0169 of neutral phosphate of lime : the solution also contained a trace of magnesia.

With respect to the calculus, Fig 40, a portion which weighed 1.2 *gramm.* was dissolved, in a similar manner, in hydrochloric acid, and also precipitated by sulphuric acid and alcohol. It

* “ It can only be fused when a very intense heat is employed such as few persons can raise.”—*Venables*.

“ Calculi of phosphate of lime blacken when heated by the blowpipe on charcoal, yield an animal odour, and at length whiten, but do not fuse.”—*Berzelius*.

“ It is known from the fusible calculus by the great difficulty experienced in even rounding the edges of its fracture by the blowpipe flame.”—*Rees*.

yielded 1.281 *gramm.* of sulphate of lime; equivalent to 1.199 *gramm.* of the neutral phosphate.

OXALATE OF LIME.*

This variety, which is extremely hard and dense, has obtained the name of mulberry calculus, from the resemblance its rugged and spinous exterior bears to the surface of that fruit; it is externally brown, or of a dull purple colour, but when pulverized, the result is a light pink or flesh-coloured powder. These characters are alone sufficient to distinguish calculi of this kind from all others, unless, as it frequently happens, their surfaces are covered, and the spaces between the tubercles filled, with the phosphatic salts.†

When sawn asunder, the nucleus is frequently found to consist of uric acid, or urate of lime. The latter appears to be the intermediate, or

* Mulberry, or mural calculus.

† It is insoluble in acetic acid, but dissolves slowly when powdered and digested in dilute nitric and hydrochloric acids.

transition state between the mulberry formation and the uric acid. Calculi, however, are far from being uncommon, which are wholly composed of oxalate of lime. In Fig. 19 the nucleus and peculiar arrangement of layers in this deposit are shown. In the original specimen, splinters of wood were found imbedded in the spines of the calculus; they appeared to have been forced into the nucleus, and gradually become incrustated with calculous material.

In order to determine the proportion in which oxalate of lime existed in this calculus, a fragment, weighing 0.928 *gramm.*, was powdered, dried by means of the air-pump and sulphuric acid, and then calcined. The residual mass, after being heated with a small quantity of carbonate of ammonia, weighed 0.520 *gramm.*; this, however, did not consist of carbonate of lime alone, for when dissolved in hydrochloric acid, and then supersaturated with ammonia, a copious white precipitate was produced; the solution was now allowed to digest for some time in a warm atmosphere, the precipitate, which

had subsided, was separated by filtration, and the clear fluid treated with oxalate of ammonia. The deposit formed by the subsequent addition of liquid ammonia, consisted of phosphate of lime, and weighed 0.058 ; the carbonate of lime, formed by combustion with carbonate of ammonia, weighed 0.462, equivalent to 0.59 of oxalate of lime. One hundred parts of the calculus were found to contain the following proportion of ingredient :—

Oxalate of lime	63.5
Phosphate of lime	6.2
Water and organic matter . .	30.3

Prout states, on the authority of Brande, that the purest specimens of mulberry calculus examined by him, contained thirty-five per cent. of other ingredients. He also observes, that the transition from the oxalate, to the phosphate of lime, takes place through the carbonate: thus, he says, “ The following is what I have observed on dissecting and analysing this variety. The nucleus had the usual appearance and composi-

tion of the mulberry calculus. Round this was deposited a substance of a less compact and more friable texture, composed of a large proportion of carbonate of lime, mixed with some oxalate of lime ; at a greater distance from the centre, the oxalate of lime entirely disappeared, and its place began to be supplied by the phosphate of lime ; the compound here, therefore, consisted chiefly of the carbonate and phosphate of lime."

The mulberry calculus exposed to the blow-pipe flame, emits a foetid odour, and becomes charred. A moderate continuance of heat expands it into a white efflorescence, which effervesces with acid, from containing carbonate of lime ; on continuing and augmenting the temperature, the carbonic acid is driven off, and the whole is converted into caustic lime. Some of these calculi effervesce with an acid before calcination,* owing to the carbonate of lime,

* The fact of effervescence occurring before as well as after incineration, induces Dr. Rees to recommend that these calculi should always be digested in hydrochloric acid before being heated, to get rid of the carbonate of lime ; if, after this, effe-

which is frequently present, associated with phosphate, as already stated. These two salts are often found strewed over the surface of these calculi.

Caustic potash, added to oxalate of lime, has no further effect than that of dissolving any animal matter with which it may been combined. But if a portion of the calculus, powdered, is digested for some time, or boiled in a solution of carbonate of potash, an interchange of principles takes place; carbonate of lime is formed and precipitates, while the oxalic acid, uniting with the potash, forms a salt which remains in solution.*

Besides the rugged calculi above described, Wollaston mentions another variety of oxalate of lime, consisting of small dark-coloured concretions, named from their appearance, hemp-seed calculi. Magendie describes another variety,

vescence follow calcination, the carbonate must have resulted from a decomposition of the oxalate. If the calculus effervesces before as well as after calcination, both carbonate and oxalate of lime must have entered into its composition.

* See Appendix, "Carbonate of potash," &c.

similar in external appearance to the uric acid, but found by Despretz, who analysed it, to be composed of oxalate of lime.* I have myself never met with a calculus of this description, although a singular concretion, which may be referred to this head, has come under my notice. Its colour is dull purple, in size it is about that of a peach-stone, and its surface is strewn with crystals of triple salt. Fig. 36 is a delineation of this calculus, which is in the possession of Dr. Christensen.

It is made up of crystals, deeply imbedded in a mass of inspissated blood. Although of a very spongy appearance, its specific gravity is 2.01, which is much greater than that of any other specimen examined: it weighs half an ounce and twenty-three grains. A fragment of it, analysed by me, weighed 1.035 *gramm.*, and was composed of the following ingredients:—

* Drs. Rees and Bird have described mulberry calculi, the surfaces of which were studded with acute octohedral crystals of oxalate of lime.

Oxalate of lime	.	.	.	.	0.383
Ammonio-magnesian-phosphate	.	.	.	.	0.413
Water	.	.	.	.	0.104
Organic matter	,	.	.	.	0.135

Marcet met with three specimens in which the oxalate of lime was crystallised ; and Wollaston represents the crystals as being octohedral.* It is stated by Yelloly, that he had met with more than thirty specimens of the crystallised oxalate in the Norwich collection.

CARBONATE OF LIME.

This salt rarely forms the chief ingredient in human calculi, although it frequently enters into their composition. It exists, however, in large proportion, and often forms the principal mass in the urinary concretions of herbivorous animals.

* Dr. Bird has described and figured three forms of oxalate of lime crystals, derived from urinary deposits. 1st. Acute octohedrons ; 2nd. Crystals resembling two superimposed cubes, a dark crystal lying over a transparent one ; 3rd. A variety never before described, resembling in outline a dumb-bell.

Proust, Cooper, Prout, Smith, Lindbergson, and Fromhertz, have described calculi in which the principal ingredient was carbonate of lime. The latter, in particular, gives a detailed description of the appearance, and quantitative analysis of a concretion of this kind.

The calculus he alluded to was round, uneven as to surface, dense, and of a brown colour externally; its size was about that of a hazel nut, and it weighed 2.12 grammes. When sawn asunder, although friable, it exhibited a fibrous structure; the cut surface was of a dirty white or grayish hue; in the centre was impacted a hard substance, slightly lustrous, and resembling a crystal of quartz.

The following was the result of the analysis:—

Carbonate of lime	.	.	.	.	70.0
Phosphate of lime	.	.	.	.	2.3
Albuminous and fibrous matter	.	.	.	.	3.1
Water	.	.	.	.	1.1
Quartz (a fragment)	.	.	.	.	4.8
Oxide of iron a trace, and loss	.	.	.	.	0.7
					<hr/>
					82.0

The effervescence arising from the disengagement of carbonic acid,* and the precipitation of lime from an acid solution of this kind of calculus, serve sufficiently to distinguish it.

It must, however, be borne in mind that the effervescence does not always indicate the escape of carbonic acid: the bubbles which arise may be those of atmospheric air, which is always displaced from the interstices of porous bodies when plunged into a liquid; or it may depend upon the expulsion of hydro-sulphuric acid gas, which is frequently contained in the calculi of animals, more especially those of oxen. The latter gas is easily detected by the odour, and by holding over the test-tube containing the effervescing mass, a slip of paper imbued with carbonate of lead recently precipitated.

* See Appendix, hydrochloric acid. &c.

CARBONATE OF MAGNESIA.

Lindbergson and Moscat detected carbonate of magnesia, combined with other ingredients, in human calculi, but never in large proportions. In the calculi of inferior animals it is frequently found; several specimens are contained in the collection of the Veterinary College, Copenhagen.*

Carbonate of magnesia is almost always associated with carbonate of lime; the separation of these two principles is easy. The mass to be examined is dissolved in hydrochloric acid; to

* The analysis given by Lindbergson is as follows:—

Urate of Soda	.	.	.	.	9.77
Subphosphate of lime	.	.	.	.	34.74
Triple phosphate	•	.	.	.	38.35
Carbonate of lime	.	.	.	.	3.14
Carbonate of magnesia	.	.	.	.	2.55
Albumen	•	.	.	.	6.87
Water and loss	.	.	•	•	4.58

100

this, hydrochlorate of ammonia is to be added, which causes a precipitation of phosphate of lime, triple phosphate, and, when present, oxide of iron. The lime is then thrown down by oxalate of ammonia, and from the solution, filtered and nearly neutralised with liquid ammonia, the magnesia may be precipitated by the addition of carbonate of potash, or phosphate of soda.* The quantitative estimation of magnesia is attended by many difficulties.

“ CYSTINE, OR CYSTIC OXIDE.

This variety of calculus was first described by Wollaston, who considered that it partook of the nature of an oxide, on account of its being soluble, indiscriminately, in both acids and alkalies. Berzelius, however, does not deem this a sufficient reason for classing it, any more than

* See Appendix,—Action of Reagents—“ Carbonate of Potash.”

other animal substances containing oxygen, among the oxides; he accordingly gives it the more appropriate name of cystine.

Calculi composed of this ingredient are of a dull yellowish-brown colour, and have generally a smooth surface, although occasionally it is studded with triple phosphate crystals. In consistence, the calculus is soft, and when cut, clogs the teeth of the saw: the cut surface presents a semi-transparent, confusedly-crystalline appearance; not, however, laminated. When broken, it appears to be made up of small crystals of a waxy lustre, the margins of which are rounded.

Crystals of cystine may be procured in a state of purity, by heating the calculus in a warm solution of caustic potash, adding to the heated solution, acetic acid in excess: on slow refrigeration, crystals appear in the form of thin, colourless, transparent, hexagonal plates. They may also be obtained by the spontaneous evaporation of cystine dissolved in liquid ammonia. The crys-

tals, thus procured, are more compact, and assume the shape of short, regular hexangular prisms.*

Cystine has neither acid nor alkaline reaction ; it does not fuse when heated, but burns with a greenish flame, and evolves a peculiar acid or acrid odour, which is quite distinctive of its presence.

On dry distillation, it yields a foetid oil, an ammoniacal liquid, and leaves a light spongy charcoal. It is sparingly soluble in water, entirely so in alcohol ; dissolves in dilute mineral acids, with which it combines, and when a sufficient quantity is present, compound crystals are deposited on evaporation. A great excess of nitric acid decomposes it, and leaves a brown stain on drying, unlike the pink colour left by uric acid.

* “ The normal crystals,” Dr. Bird observes, “ appear under the form of tolerably regular six-sided tables, sometimes transparent, but more generally *opaque in the centre* :” they also occur as roundish tables, the opacity sometimes general, at others only central ; they are somewhat crenate at the edges.

It is soluble in the caustic fixed alkalies and their carbonates; soluble also in caustic ammonia,* but not in its carbonate: and insoluble in acetic, tartaric, and citric acids.

Carbonate of ammonia affords the readiest agent for precipitating it from its acid solutions, and acetic acid from its solution in the alkalies.

In human calculi it is seldom, if ever, combined with other ingredients;† but, in those of the inferior animals, it is generally associated with the phosphates.

Thaulow has recently analysed a calculus of this species with great care, and, in addition to carbon, nitrogen, hydrogen, and oxygen, found

* “When cystic oxide is suspected to exist in a calculus, the readiest mode of detecting it is to digest some of the powder in a warm solution of ammonia, and allow a drop of the clear fluid to evaporate spontaneously on a slip of glass. The crystals of cystic oxide, if present, will then be readily recognised by microscopic examination.”—*Bird's Observations*, p. 195.

† Dr. Bird gives a drawing of a calculus consisting of two green zones of cystic oxide, separated by a layer of urate of ammonia, and deposited on an oxalic nucleus.

that it contained sulphur. The following is the formula he gives: $C_5 N_2 H_{12} O_4 S_2$.

ORGANIC INGREDIENTS.

To this head may be referred inspissated mucus, blood, fibrin, albumen, and other substances of a similar nature, which have not as yet been examined with much attention, although they are more or less present in all calculi. Some concretions, which at first sight appeared to have been composed entirely of inorganic salts, have, on being heated to redness, revealed their organic composition by becoming completely consumed.

Marcet gives an account of a calculus of this description, which he detected. It was of the consistence and colour of yellow wax, and about the size of a pea; the surface uneven, but not rough; its texture fibrous, rather than laminated, the fibres appearing to radiate from a centre.

Heated in the flame of a spirit-lamp, it inflamed, swelled, blackened, and was finally reduced to the state of a light spongy charcoal. During combustion, it emitted an animal odour, dissimilar from that of uric acid, uric oxide, or cystine.

It was insoluble in water, or dilute hydrochloric acid; boiled with caustic potash, it formed a saponaceous solution, from which it was separated by the addition of hydrochloric acid. Nitric acid dissolved it, but without leaving the pink stain on evaporation, indicative of uric acid. Boiled with dilute acetic acid, it at first increased in bulk, and at length dissolved: ferro-cyanate of potash, added to the solution, produced a yellow precipitate.

Marcet gave it the name of fibrinous calculus; to which Berzelius objects, observing that solubility in nitric acid is neither a property of albumen, nor of fibrin; that, therefore, some other substance must have entered into the composition of this calculus. No. 110 in the Museum catalogue refers to the only specimen of

this variety which is worthy of being mentioned.

It is a fibrous mass, said to have been taken from the bladder of a male subject after death. It weighs 255 grains, and has been divided into two parts, each of which is about the size of a walnut. The whole mass is friable, it nevertheless cuts like wax, and has a waxy lustre: it may be partially pulverised, but a portion of the powder always retains a fibrous character. Boiling alcohol dissolves some adipose matter; water scarcely takes up any portion of the substance, but nevertheless acquires a yellow tinge. Potash dissolves it in a great degree, and from this solution, hydrochloric acid throws down a yellow precipitate. It is partially dissolved, by boiling, in acetic acid, and precipitable by ferrocyanate of potash, and also by ammonia, in the shape of a white sediment; the latter precipitate, on being heated, blackens, and, when sufficiently incinerated, leaves a residuum of phosphate of lime. Dilute nitric acid dissolves the latter salt, but has no effect on the organic ingredients,

which are, however, soluble in caustic potash. The incineration of 0.879 *gramm.*, in a platinum crucible, produced 0.392 of phosphate of lime, equal to rather more than forty-four per cent. I consider this calculus, therefore, to be composed of phosphate of lime, fibrin, fat, colouring matter, and a small quantity of undefinable animal substance.

SILEX.

Silex has hitherto been seldom found as a constituent of calculus; that which I have seen, during my examination of calculi, has been obtained from those with rough and uneven surfaces, by washing them; diligently separating, by means of the filter, the solid particles, and the shreds of mucus suspended in the water. These, after incineration, have occasionally afforded a few grains of sand, which, however, I am disposed to think had been conveyed into the bladder fortui-

tously, and had become attached to any nucleus that happened to be present. It is also my opinion, that the specimen, No. 45 in the catalogue, consisting of silica, with several laminæ of mica, owes its origin to the introduction of these ingredients into the bladder, rather than to their separation from the urine.

The concretion in question is not of a firm texture, but readily pulverisable; the various ingredients of which it consists are distinguished with ease. When boiled in a solution of carbonate of soda, a portion of the powder is dissolved. This and various other circumstances connected with the history of the concretion, and the absence of all organic ingredients, such as are generally incorporated with calculi, lead me to question its origin, and to doubt its ever having been extracted from the bladder.

In the collection of the Veterinary College, a small calculus is to be seen, sent thither by Holmia of Engstrom, which consists of a fragment of quartz, surrounded by a coating of carbonate of lime. Yelloly examined a fragment

of calculus, weighing about nine grains, consisting of oxalate of lime and other ingredients; these were separated from each other, partly by solution in hydrochloric acid, partly by incineration: the residue of the latter contained some transparent colourless granules, capable of scratching glass and agate, but insoluble in hydrochloric and nitric acids.*

This description sufficiently proves that the silex did not exist in a state of solution in the bladder; for the temperature at which organic matter is dissipated, can scarcely be sufficiently intense to fuse silex into a transparent mass; and if not fused, it would scarcely have been in a condition to scratch glass and agate.

* Dr. Venables, about the same period, published an account of some siliceous gravel detected by him, which he seems to be satisfied was of urinary origin. It does not seem to be a question as to the presence of silex, in certain concretions supposed to be urinary, the only doubt is as to their real origin.

OXIDE OF IRON.

Wurtzer and Fromhertz are said to have found traces of iron in vesical calculi. I have very rarely detected any of this metal; which may depend upon the small portions I have been permitted to operate upon at a time. There is no doubt, however, that its presence may be easily verified where larger portions are examined; and for the following reason, fragments of steel instruments frequently remain in the bladder quite long enough to be oxidated and dissolved.

OXALATE OF AMMONIA.

This salt is enumerated among the constituents of calculi by Martin, on the authority of Ratie, Duvergie, and Bechard. It is difficult, however, to understand how a salt, so easy of

solution, should ever have formed a nucleus for the deposition of uric acid. I am inclined to believe that some of those azotized principles, which either form uric acid, or prepare the way for its formation, must have been mistaken for oxalate of ammonia.

BENZOATE OF AMMONIA.

Brugnatelli asserts that this salt was recognised by him, combined with carbonate and oxalate of lime, and some glutinous substance. The calculus he alludes to was extracted from the bladder of an adult male; it was of the size of a nut, light but dense, with an unequal granulated surface, interspersed with small foramina. When divided, it seemed to be composed of small, compact, greyish crystals.

SECTION II.

CLASSIFICATION OF CALCULI.

Various methods of classifying urinary concretions, have at different times been devised; some founded on their sensible properties, and others on their chemical composition. The most natural arrangement, however, seems to be that in which not only the whole of the constituents are enumerated, but also the order of their succession. In order to facilitate their identification, it is also necessary to class them according to their chemical properties. In the following pages both these plans have been adopted.

It will be found, in the accompanying table, that the ingredients forming the nucleus have been arranged in the first column; in the second,

those constituting the body, or principal mass; and in the third, the material of which the cortex, crust, or external covering, is composed. When the latter coincides in composition with that of the principal mass, a blank space has been left.

This kind of subdivision seems to be pointed out by the structure of the calculi themselves, and should never be neglected by those who seek to analyse them. The external layers of a calculus frequently bear but a small proportion to the whole, and differ in composition from the rest of the mass; mere inspection, therefore, will convey little real information as to their nature; nor can the examination of a powder, filed off from the sectional surface of a calculus, give a just idea of the proportions in which the different ingredients exist.

It is much to be feared that, from neglecting these precautions, many tables of the comparative frequency of different varieties of calculi, have been drawn up on false principles.

TABLE OF VESICAL CALCULI.

NUCLEUS.		PRINCIPAL MASS.		CORTEX	No.
1	Uric acid	-	Uric acid	Uric acid	32
2	"	-	Uric acid, and urate of ammonia alternating	Urate of ammonia	1
3	"	-	Uric acid	Phosphate of magnesia	13
4	"	-	Urate of ammonia	-	3
5	Urate of soda	-	Uric acid	-	1
6	Urate of lime	-	Urate and oxalate of lime, and urate of ammonia	-	1
7	Oxalate of lime	-	Uric acid	-	3
8	"	-	Uric acid and phosphates mixed	-	1
9	Triple phosphate	-	Triple phosphate	-	8
10	Fusible matter	-	Fusible matter	-	6
11	Urate and oxalate of lime	-	Oxalate of lime	-	8
12	"	-	"	-	13
13	"	-	Oxate and urate of lime alternating	Phosphates	3
14	Urates of ammonia and lime	-	Urate of ammonia and lime alternating	Phosphates	2
15	Uric acid and urate of ammonia	-	Urate of ammonia and phosphates mixed	-	2
16	Uric acid and urate of lime	-	Oxalate of lime	-	2
17	"	-	Phosphates	-	2
18	"	-	Uric acid	-	27
19	Uric acid, urate and oxalate of lime	-	Phosphates	-	2
20	Uric acid, urate and oxalate of lime	-	Uric acid	-	17
21	Silica	-	Silica	-	1
22	"	-	Carbonate of lime	-	1
23	Foreign materials	-	Phosphate of lime	-	2
24	No nucleus	-	Phosphate and carbonate of lime	-	1
25	"	-	Phosphates	-	2
26	"	-	Fibrous matter and phosphates	-	1
Sum total of Calculi					155

Thus, in 94 the principal mass is uric acid = 60 per cent. = 1 : 1 $\frac{2}{3}$
 23 " " oxalate of lime = 15 " = 1 : 6 $\frac{2}{3}$
 25 " " Phosphates = 16 = 1 : 6 $\frac{1}{4}$

If the above comparisons had been deduced from external inspection alone, the predominance would have been in favour of the phosphates, instead of the urates. It will be seen that, 73 specimens coated with the phosphates, i. e. 47 per cent. or $2\frac{6}{74}$, are in fact chiefly composed of uric acid and its modifications.

For the following table, showing the comparative prevalence of the different species of calculi in various collections, I am indebted to Martin's "*Commentatio Medica de Lithogenesisi.*"

Proportions between the Oxalates	Urates and	Phosphates
1 Hunterian museum = 1 : 13.5	= 1 : 2.46	= 1 : 2
2 Guy's Hospital = 1 : 3	= 1 : 4	= 1 : 3
3 Wood's Collection* = 1 : 3	= 1 : 1.18	= 1 : 7
4 Norwich Hospital = 1 : 2.9	= 1 : 3	= 1 : 7.6
5 Marcet = 1 : 3	= 1 : 2.7	= 1 : 3.2
6 Manchester = 1 : 10.33	= 1 : 2.2	= 1 : 8.5
7 Bristol = 1 : 3.33	= 1 : 3.33	= 1 : 10.89
8 Swabia (Rapp) = 1 : 1.43	= 1 : (11.5) 1.21	= 1 : 10.1
Total (1400) = 1 : 4	= 1 : 1.87	= 1 : 1.5

* Wood e Collectionibus Scholæ in Windmill Street, Conditæ.

Lond. Med. and Phys. Journ., No. lvii. p. 29. Jan. 1827.

Crosse has also given a table of the comparative composition of small calculi voided through the urethra.

Uric acid and urate of ammonia	.	.	72
Uric acid and oxalate of lime	.	.	9
Oxalate of lime	.	.	14
Carbonate of lime	.	.	1
Triple Phosphate	.	.	2
Fusible	.	.	2
			<hr/>
			100

The small number of phosphatic calculi included in this last list, confirms the opinion, previously expressed, that the phosphates are chiefly deposited as an external coating on calculi of large size.

Having, in the preceding section, treated generally of the physical, as well as chemical properties of vesical calculi, I shall now proceed to classify them, and to give more detailed instructions for the separation and examination of their various constituents.

The classification I propose, is founded on the changes which are produced on calculous con-

cretions, by exposing them to a high temperature.

The effect first produced on a fragment exposed to the blowpipe flame is, that it becomes charred, owing to the combustion of the animal matter calculi always contain.

If the heat be continued, or augmented, one of the following conditions is fulfilled,—

1st. The fragment gradually consumes, leaving no residuum, or a very slight one.

2nd. The fragment does not consume ; it either whitens after being charred, and remains unchanged, or it fuses into a bead.

3rd. The fragment partially consumes, leaving a considerable proportion of residuum.

These three obvious differences of behaviour, under parallel circumstances, naturally suggest the division of calculi into three classes.*

CLASS 1st. COMBUSTIBLE CALCULI, which consume on being sufficiently heated, leaving a very minute residuum.

* See Appendix.

CLASS 2nd. NON-COMBUSTIBLE CALCULI, which do *not* dissipate under calcination,

CLASS 3rd. PARTIALLY-COMBUSTIBLE CALCULI, which, after combustion, leave a considerable proportion of residuum.

The 1st class includes the following orders:—

- a. *Uric acid.*
- b. *Uric oxide.*
- c. *Cystine.*
- d. *Combinations of the three preceding, with each other, or with other combustible materials, such as ammonia, &c.**

The 2nd class includes the following orders:—

- a. *Phosphates.*
- b. *Carbonates.*
- c. *Silica.*
- d. *Mixtures of the preceding.*

The 3rd class includes the following orders, namely, compound calculi, formed by the combination of the species contained in the two former classes.

* See Appendix.

- a. The residuum consisting of the phosphates.*
- b. The residuum consisting of carbonate, or caustic bases.*
- c. The residuum consisting of phosphates, with carbonate or caustic bases.*
- d. The residuum consisting of accidental ingredients, either alone, or mixed with the foregoing.*

The objection urged against this sort of arrangement, is the necessity it involves, for having recourse to experiments, for the mere purpose of classing the calculus. But, it should be remembered, that if accuracy is desirable, chemical investigation must, ultimately, be resorted to; these simple experiments, therefore, are not only so many preliminary steps in the analysis, but in themselves convey so much collateral information, as frequently to do away with the necessity for further inquiry.

It would certainly be more speedy and more convenient if a useful classification could be framed, from the aspect of calculi alone; but, as this does not denote their internal structure, the

most accurate inspection, although it may aid, can never supersede chemical examination.

SEPARATION OF THE CONSTITUENTS OF CALCULI.*

I shall now proceed to describe the methods I have usually pursued in the examination of vesical calculi, in order to separate and insulate the proximate principles of which they are formed.

Previously to the chemical examination of a calculus, it should be washed in cold water, to detach and dissolve any adherent matter, such as mucus, urea, soluble salts, &c. As urea leads to the generation of ammonia, when the assay is heated with caustic potash, its presence would prove a source of error. The calculus should, in addition, be washed with alcohol and æther, to free it from resinous or adipose impurities.

If these several liquids are supposed to contain any essential ingredient, removed from the sur-

* See action of reagents, blowpipe analysis, &c., Appendix.

face of the calculus, which, however, is seldom the case, unless silex be suspected, they are to be carefully evaporated, and the residua submitted to such tests as may be deemed necessary.

Examination of Class 1st.

The three first orders of this class, uric acid, uric oxide, and cystine, each consisting of a single principle, are easily identified by attending to the characters already given under their several heads.

All calculi contain more or less of vesical mucus, blood, or other animal matter, acquired during their formation, their transit through the ureters, or their exit through the urethra; these, however, are dissipated by heat, and do not interfere with the further steps of the examination.

The fourth order includes urate of ammonia, either alone or combined with uric acid; these ingredients may be readily recognised and separated as follows: A portion of the calculus should be boiled, for a short time, in

a sufficient quantity of pure water, to dissolve the urate of ammonia; the liquid is to be filtered hot. The addition of dilute hydrochloric acid, when cool, renders the solution turbid, and precipitates the uric acid, which may be separated, by the filter, for special examination.* The clear fluid, carefully evaporated, yields crystals of hydrochlorate of ammonia.

Combinations of uric acid, and urate of ammonia, may be similarly treated; those of cystine, with uric acid and uric oxide, have not been detected, any more than mixtures of uric acid and uric oxide. Should such a compound as the latter be discovered, the oxide may be separated from the acid by digestion in concentrated sulphuric acid; the addition of water to the solution would precipitate the uric acid alone.

* This may consist in the examination of the form of crystal by the microscope, or testing with nitric acid and ammonia.—See action of reagents, Appendix.

Examination of Class 2nd.

The first order contains phosphate of lime, triple phosphate, and the fusible phosphates.

Phosphate of lime is found either neutral or basic: in the first state it seldom occurs alone, but may be easily separated from other ingredients, by the means before mentioned. The basic variety is, invariably, combined with other materials; when mixed with triple phosphate, the fusible character of the compound sufficiently distinguishes it. When mixed with the carbonates the combination belongs to the fourth order of the present class. The properties of the ammonio-magnesian, or triple phosphate, have already been treated of fully. The means of separating it when united with other matters will be presently mentioned.

The second order comprises the carbonates. Those of lime and magnesia have, hitherto,

always been found united, and occasionally associated with a small quantity of silex as well.

The separation of lime from the other ingredients, is effected by dissolving the calculus in dilute hydrochloric acid; active effervescence ensues, which, when it arises from the escape of carbonic acid,* characterises these calculi. The solution thus formed of lime and magnesia must be separated by filtration from vesical mucus, and other impurities, which render it turbid. The addition of sulphuric acid and alcohol, precipitates the lime in the state of sulphate. When the whole of it has subsided, the liquid is again filtered or decanted, and must then be treated with ammonia and phosphate of soda, in order to precipitate the magnesia.†‡

The third order includes those rare calculi which are said to contain silex. This ingredient is recognised by its resisting the action of all

* See list of reagents, Hydrochloric Acid, § 4.

† See list of reagents, Ammonia, § 9.

acids except the hydrofluoric :* its properties are, however, fully described in a former section.

The fourth order chiefly consists of combinations of the phosphates with the carbonates.

Mode of separation.—The first step is to expose a fragment to the flame of the blowpipe ; if it fuses readily its character is thereby determined ; but if it does not, the residue must be submitted to the following treatment. It must be dissolved in dilute nitric acid, and the carbonaceous matters, resulting from the process of incineration, removed by filtration. The salts which the clear fluid contains are to be precipitated by carbonate of potash or soda : the precipitate, thus obtained, is to be digested with acetic acid, somewhat diluted,

* The following passage is extracted from Dr. VENABLES' lectures in the Med. Gazette for 1833 :—

“ The most distinctive character of silix is its action with soda. If I heat some of it with carbonate of soda on charcoal before the blowpipe, you will observe first an effervescence, owing to the disengagement of carbonic acid gas ; the silicea and the soda then fuse into a bead of glass, which will retain its transparency on cooling, and remain free from colour.”

which dissolves the carbonates and the triple salt, leaving the phosphate of lime undissolved. The latter is to be collected on a filter and reserved for future examination. The addition of hydrochlorate of ammonia to the acetic solution, throws down the the triple salt, which is to be removed by filtration ; any lime which may still be present, resulting from the carbonate, is precipitated by oxalate of ammonia, and subsequently, on the addition of phosphate of soda, the magnesia also subsides.

In order to ascertain the nature of the ingredients in the precipitate left on the filter, it must be boiled in concentrated nitric acid ; to this a solution of nitrate of silver must be added, and afterwards liquid of ammonia : when the acid is nearly neutralized, a yellow precipitate of phosphate of silver will appear. When the whole of the latter has subsided, lime may be tested for, in the usual way, with oxalate of ammonia.

Examination of Class 3rd.

The examination of the third class, which con-

tains the mixed and alternating calculi, is much more intricate than that of the two former; for, it is not only requisite to determine the nature of the combustible, as well as incombustible ingredients which form the concretion; but also to ascertain if the former are merely mixed with the latter mechanically, as where uric acid alternates with the phosphates, or whether they form chemical compounds with the various inorganic bases; as is the case in calculi composed of urate and oxalate of lime, &c. Sometimes, indeed, the combustible ingredients are met with in both forms; as for example, in calculi composed of the urates and phosphates, with pure uric acid.

In examining the following orders, much error will be avoided by directing attention to the inorganic materials contained in the residua, rather than to the other ingredients, which are destructible by heat.

The first order of mixed calculi contains,

1. The phosphates with uric acid.
2. The phosphates with urate of ammonia.

3. The phosphates with cystine.

4. The phosphates with uric oxide.

5. The phosphates with the combustible ingredients included in the first class.

The phosphates with uric acid.—These ingredients are easily separable by boiling the calculus in dilute hydrochloric acid; on cooling, the uric acid subsides, while the phosphates remain in solution. This separation may also be effected by means of caustic potash, which dissolves the uric acid alone, but this is not so accurate a process as the former.

The phosphates, with urate of ammonia, may be separated by boiling the fragment in water, so as to dissolve the urate of ammonia, which is to be removed from the insoluble phosphates by filtration while warm. The addition of hydrochloric acid to the solution, when cold, precipitates uric acid; ammonia unites with the hydrochloric, and the compound may be obtained in crystals by careful evaporation.

If pure uric acid is present, in conjunction with the above mixture of ingredients, the urate of

ammonia must be dissolved by boiling in water and filtering; the residuum may then be treated in the same manner as the combination of uric acid with the phosphates.

The second order contains the following species:

1. Oxalate of lime.
2. Oxalate of lime and uric acid.
3. Uric acid and urate of lime.
4. Urate and oxalate of lime.
5. Uric acid, with urate and oxalate of lime.

Oxalate of lime may be distinguished by the characters already enumerated.

Oxalate of lime and uric acid.—This combination must be boiled in a solution of caustic potash; by this means the uric is dissolved, and the oxalate of lime subsides as an insoluble precipitate.

The same end is to be attained by an opposite process, viz., the calculus powdered may be boiled in hydrochloric acid, which dissolves the oxalate of lime, and precipitates the uric acid.

Uric acid and urate of lime may be separated by boiling the compound in water, whereby the

urate of lime is dissolved from the uncombined uric acid; the liquid must be filtered, and on the addition of hydrochloric acid, uric acid in union with lime precipitates, whilst the lime itself unites with the hydrochloric acid, and a solution of hydrochlorate of lime results.

Urate and oxalate of lime.—These ingredients may be more effectually separated, by boiling in water, than the former, in consequence of the perfect insolubility of oxalate of lime in water at any temperature, which is not the case with uric acid.

Uric acid with urate and oxalate of lime.—To separate the ingredients of this compound it is to be boiled in water, so as to dissolve the urate of lime; the portion remaining undissolved is to be boiled with caustic potash, which will take up the uric acid. The oxalate of lime remains as an insoluble powder.

Occasionally calculi are met with composed of the three above-mentioned ingredients, in addition to urate of ammonia. The same modes of separating them may be resorted to; but, it becomes a question whether the watery solution,

after the precipitation of the uric acid by the hydrochloric, does not contain a mixture of hydrochlorate of ammonia and lime.

The third order includes all calculi consisting of the phosphates, oxalates, and urates. The residua of these are formed of the phosphates, with other bases, either caustic or united with carbonic acid.

1. Phosphates with urate of lime.
2. Phosphates with urate of lime and uric acid.
3. Phosphates with urates of lime, and ammonia, and uric acid.
4. Phosphates with oxalate of lime.
5. Phosphates with oxalate and urate of lime.
6. Phosphates with oxalate and urate of lime, and uric acid.
7. Phosphates with urate of magnesia and uric acid.

In the examination of calculi belonging to the foregoing orders, we can have little doubt as to the manner in which the ingredients were associated: for instance, if we meet with a calculus composed of uric acid, with a small quantity of

phosphoric acid and lime, there can be no hesitation in pronouncing it to consist of uric acid and phosphate of lime, rather than urate of lime and phosphoric acid. But in analysing specimens belonging to the present order, it will be much more difficult to discriminate: thus in a concretion in which ammonia, magnesia, phosphoric and uric acids are found to exist, we shall not be able to determine, without having recourse to experiment, whether part of the ammonia is united with the uric acid, or the whole of it combined with magnesia and phosphoric acid. In the one case, forming a compound of urate of ammonia with triple phosphate; in the other, triple phosphate with free uric acid.

It frequently happens that the different ingredients are arranged in layers sufficiently distinct to admit of mechanical separation: whenever this is feasible it should be done, and each layer be analysed separately. This assuredly increases the amount of labour, but it simplifies each process, and tends to elucidate the composition of the calculus much more accurately, than when

a portion, removed indiscriminately from the whole of the cut surface, is examined.

In the analyses, of which the following details are the results, I have been guided by the principles herein recommended; considering the nucleus, the body, and the crust, as so many distinct structures, to be separately examined.

Urate of lime with the phosphates.—By boiling the assay in water, the urate of lime is dissolved, and the whole of the phosphate subsides on the refrigeration of the solution; this, when filtered, is to be treated with hydrochloric acid, which forms a soluble salt with the lime, and causes the uric acid to deposit. The phosphates remaining on the filter may be examined in the usual way.

Uric acid with urate of lime and the phosphates.—This is a frequent combination, owing to urate of lime constituting the transition between the two other principles. The mixture must be boiled in water to dissolve the urate of lime; the precipitate collected on the filter is to be treated with hydrochloric acid, which precipitates the uric acid, and dissolves the phosphates.

It should here be remarked, that, as a greater or less quantity of carbonate of lime and of magnesia always exist in combination with the phosphates, the addition of hydrochloric acid will generally occasion some slight degree of effervescence.

Uric acid, and urates of lime and ammonia, with the phosphates.—These ingredients are separable as follows. A portion of the calculus, powdered, must be boiled in water, and after cooling, filtered; to the limpid solution, hydrochloric acid is added, which forms soluble salts with the ammonia and lime; the uric acid being deposited, must be removed by filtration. The solution must now be evaporated to dryness and the heat continued, until the hydrochlorate of ammonia sublimes, whereby it is separated from the chloride of calcium. The residuum remaining on the first filter, which was not dissolved by boiling in water, must be treated with acetic acid, which dissolves the triple phosphate. Uric acid and phosphate of lime remain, and these may be separated by dilute hydrochloric acid, which dissolves the latter but not the former.

Phosphates and urates of lime and ammonia, with oxalate and carbonate of lime.—This compound must be boiled in water to dissolve the urates, which may then be separated as above directed. The portion remaining undissolved, is to be boiled in acetic acid, which takes up the triple phosphate and the carbonates. The triple salt is to be precipitated from the acetic solution by hydrochlorate of ammonia ; the bases, united with carbonic acid, are to be tested for in the filtered solution.* The mass not soluble in acetic acid, consists of uric acid, with oxalate and phosphate of lime ; the uric acid is separated from the rest by boiling in a weak solution of caustic potash. The residuum, well washed, must now be incinerated, whereby the oxalate of lime becomes a carbonate ; the whole is then to be dissolved in hydrochloric acid, from which the phosphate of lime is precipitated by ammonia ; the lime, resulting from the carbonate, remains in solution, and may now be separated in the usual way.

Combinations of the oxalates and phosphates, without an admixture of uric acid or its salts, are

* See Appendix.

seldom met with. The means, however, of separating these ingredients, are, first, dissolving out the carbonates and the triple phosphate by acetic acid ; the residuum, after being washed and incinerated, is dissolved in hydrochloric acid, which solution, when neutralised with ammonia, will yield the phosphates, as before stated.

The mode of treating concretions in which urate of magnesia is present has already been fully detailed.

The fourth order includes silica and extraneous matter of various descriptions ; these may be detected after combustion, and for their separation from the other ingredients, the usual methods of chemical analysis are to be pursued.

ON THE ORIGIN AND INCREMENT OF CALCULI.

From all the observations that have been made on the subject of urinary calculi, it is pretty evident, that their mechanical formation depends on the gradual deposition of minute particles, either amorphous or crystalline, on some solid

or gelatinous molecule existing in the bladder. This mass is sometimes a small calculus which has descended from the kidneys ; at others, a foreign substance, accidentally present in the bladder. The latter circumstance takes place frequently in women, the conformation of whose urethra more readily admits the entrance, and permits the egress of solid bodies; and thus, as small calculi are more readily got rid of by them, one source of increase is avoided, and we find that they are much less liable to suffer so severely from this complaint, as the other sex.

When instruments, such as bougies and catheters, are allowed to remain for any length of time in the bladder, they become coated with a deposit from the urine ; which deposit, generally, consists of the phosphates. Other substances, resident in the bladder, also acquire this sort of incrustation. Marcet, on the authority of Mac Gregor, mentions the case of a soldier who received a bullet in his bladder, which, on subsequent extraction, was found covered with fusible deposit.

As similar phenomena occur when a solid sub-

stance is placed in concentrated saline solutions, it may reasonably be inferred, that urinary concretions are formed by a similar process of deposition or crystallization. This idea is further supported by the fact, that the chief ingredients precipitated on foreign bodies, are the earthy phosphates, which, as they are extensively soluble, so are they the more readily crystallizable.

Prout and Forbes, however, entertain a somewhat different opinion ; they consider that precipitation does not occur until the foreign substance has produced so much irritation, as to affect the kidney sympathetically, so as to cause secretion of urine supersaturated with precipitable salts. Forbes further states, that diseases requiring the use of the catheter are generally accompanied by a phosphatic condition of urine : this, however, is not always the case, for instruments are frequently, on removal, found to be incrustated with carbonate of lime.

Calculous nuclei, however, it must be remembered, are not always of foreign origin, being often formed in the kidney ; from thence descending into the bladder. But a knowledge of

their chemical composition does not imply any information as to their mode of formation.* Moreover, they often exist without producing any inconvenience during life; and have been taken from the kidney, after death, without any previous suspicion of their presence having been excited.

Berzelius considers, that urinary concretions form under the following circumstances. First, owing to the kidney's secreting an over-abundance of the salts sparingly soluble in urine. Secondly,

* Dr. Prout thinks that uric acid is capable of existing in the kidneys, in a semi-fluid state, as when precipitated from an alkaline solution by muriatic acid; and that this hydrate readily becomes consolidated, so as to form a calculus and a nucleus for fresh deposits.

This position is, to a certain degree, exemplified by a case I met with some years ago, in which a concretion had formed in a sinus which existed in a prepuce covering and adhering to the glans. The urethral orifice was contracted, and a portion of the urine being constantly retained in this sinuous pouch, speedily gave rise to the formation of an uric concretion of the size of a split pea. It did not contain mucus, or any other material in the shape of nucleus; and must therefore have been deposited in the state of hydrate, from urine in every respect healthy.—*Trans.*

the absence of a sufficient quantity of free acid to retain the ordinary proportion of phosphatic salts in solution. Lastly, a morbid tendency in the kidney to secrete matter not naturally contained in the urine, such as oxalate of lime, which, being insoluble, precipitates as soon as formed. Any of these conditions occurring, deposits, he says, take place, which are either carried out of the system in the form of gravel, or become consolidated, and remain for a time in the pelvis of the kidney, from whence in all probability they ultimately make their way into the bladder.

When renal calculi have descended into the bladder, unless speedily expelled, they act as foreign bodies, affording a foundation for subsequent deposition.* The degree of rapidity with which precipitation takes place, depends on various causes. Among these may be enumerated, the envelopment of the nucleus, in albumen, blood, mucus, pus, or any other organic matter

* "There is not a body to which the elements of a calculus are more easily united than to a calculus itself, * * * * for which reason, a renal stone is most frequently the basis of one in the bladder."—*Coulson on the Bladder and Prostate. 3rd Edition.*

that chances to be present in sufficient quantity. These form a villous coating around the solid material, and their flocculi arrest, entangle, and ultimately determine the crystallization of the more insoluble ingredients of the urine. This explanation will go far to account for the animal matter contained in all calculi; the presence of which adds so greatly to the difficulty of distinguishing their constituents. It accounts also for the spongy interstices interposed between layers of a denser structure; and explains why certain calculi are full of small foramina.

These organic substances, as they exist so constantly in calculi, may be regarded as the cement which binds calculous constituents together; and not only favours their increase, but in very many instances first lays the foundation for precipitation. If we attentively examine any of the fissured and perforated calculi so often met with, or those in which a central mass of crystals replaces the usual nucleus, we shall have evidence of the manner in which a clot of blood, or a flake of mucus or albumen, detain the

solidifiable ingredients, —“the hydrate,” as it were, and form the elements of a nucleus, which consolidates, and in its turn constitutes the centre for future deposition.

With respect to calculi which contain a central cavity lined with crystals, it is difficult to ascertain whether these crystals form during the residence of the concretion in the bladder; or, whether crystallization takes place subsequently, owing to dissipation of the watery parts of the urine contained in the interstices of the stone at the period of its extraction,—a question which can only be determined by making sections of perfectly recent calculi. This I have not had sufficient opportunities of doing, as most of the specimens that have come under my observation had been for years in the collection.

Prout has most ably treated on the subject of the transitions which take place from one species of deposition to another, pointing out the order of succession as well as the intermediate characters they assume during the intervals. Thus, he proves that the transition from the oxalate to the phos-

phate takes place through carbonate of lime ; and that urate of ammonia is the intermediate formation between uric acid and the phosphates. My own observations, in numerous cases, enable me to arrive at the conclusion, that urate of lime generally forms the link between uric acid and mulberry deposits.

This subject is full of interest, and not yet sufficiently investigated ; much light may, however, be thrown on it, by patiently observing and recording the daily variations which occur in the health of calculous patients ; influenced, as these variations are, by the quality of the ingesta and egesta, the nature of the medicines exhibited, &c. It is very probable, that, as the developement of the annual rings in trees is influenced by temperature, moisture, and other modifications of the seasons, so does the state of a patient's healthy influence the succession of any calculous deposit to which he may be liable. It would be desirable to be able to institute a correct comparison between the changes which occur in the constitution during the disorder, and the variations in the

characters and arrangement of the various layers of the concretion after extraction. That this connexion has not been more frequently established depends, no doubt, on the interval generally allowed to elapse between the extraction of the calculus and its dissection ; in consequence of which, the more minute details of the patient's history are lost sight of.

As the phosphates are the salts most frequently deposited on foreign bodies, it has been supposed that the presence of the latter create a special disposition to the precipitation of this kind of salt, either directly by local irritation, or indirectly by producing that state of constitutional disturbance which follows protracted suffering ; often changing the action of the kidneys, and vitiating the quality of their secretion. Phosphatic deposition has also been ascribed to the use or abuse of alkaline medicines ; a question which will be presently considered.

Cases in which uric acid is deposited on phosphatic concretions do occasionally occur, but merely as exceptions to the law stated by Prout,

that, "A decided deposition of the mixed phosphates is not followed by other depositions." When, however, it does take place, the tenuity of the uric acid layer is such, as to render the exception "more apparent than real."

As regards the formation and increase of unstratified calculi, Crosse says, that when a calculus remains constantly in one position, deposition ceases at the point of contact, and only takes place on the free surface.

ON SOLVENTS FOR THE STONE.

Various menstrua have, at different periods, been recommended and exhibited, for the dissolution of gravel and calculus. I shall, first of all, notice those which are stated to be most effectual in uric acid cases; as this kind of concretion is, by far, the most frequent of any.

Uric acid, as Prout observes, requires ten thousand parts of cold water for its solution; whereas, its combinations, either with fixed

or volatile bases, are readily soluble in four hundred and eighty parts of water. Hence, the carbonates of soda and potash are very available as solvents for this modification of concretion.

The effects of these salts are not, however, confined to the urates alone ; they are equally efficacious as solvents for oxalate of lime and phosphatic calculi, a property not sufficiently appreciated. The decomposition, which takes place on digesting oxalate of lime in a solution of the alkaline carbonates, has long been established ; and I have ascertained by repeated experiments, that the natural temperature of the body suffices to produce an interchange of principles, so that carbonate of lime and oxalates of soda or potash shall result.

The two latter salts are soluble in water alone, the former in water impregnated with carbonic acid. It is well known, that the combination of oxalic acid and lime forms the most insoluble of all the calculous concretions.

The phosphates are, undoubtedly, decomposed by the alkaline carbonates, especially the basic

and neutral phosphate of lime; the effect is increased by using the bicarbonates.

The beneficial effects produced by certain mineral waters, such as those of Vichy, Carlsbad, and many others, are no doubt owing to the alkaline carbonates they contain. In cases where the alkalis have failed to relieve, or where they disagree with the digestive organs, carbonate of magnesia has often been substituted with great advantage, the calcined earth has also been given. Lime-water and carbonate of lime, the chief ingredient in Stephen's remedy, are occasionally useful.

But, the direct administration of the alkaline carbonates, is not the only, and not always the best way of employing them. For, according to Wöhler's experiments, the neutral salts formed by vegetable acids become converted by a vital process into carbonates during their transit through the system; and render the urine, not only decidedly alkaline, but capable even of effervescing with acids.

Caustic potash, as it is a more powerful solvent of uric acid than the carbonate, is frequently of

use ; and I do not think, when given properly, it can produce any evil consequences.

Among the remedies prescribed in calculous cases, there are other salts which, although not convertible into carbonates, are very useful as solvents ; one of these is borax, a dilute solution of which is capable of dissolving a larger quantity of uric acid than the carbonates either of soda or potash. Wetzlar,* in 1821, first noticed the solubility of uric acid in this salt. More recently, Boettiger has experimented on the subject, and finds that four grains of biborate of soda, dissolved in an ounce of water at 98° F.,

* Uric acid, digested in an alkaline carbonate, disengages the carbonic acid with difficulty ; an alkaline carbonate and biurate result. Wetzlar says, that when water, having one twelfth of its weight of carbonate of potash or soda in solution, is digested with uric acid, part of the alkali is precipitated in combination with uric acid, and the remainder converted into a bicarbonate. But if, on the contrary, the alkaline solution is much weaker, uric acid is dissolved with tolerable rapidity. The same thing happens with respect to a solution of uric acid in borax ; the boracic acid, however, being more readily displaced than the carbonic, a greater proportion of uric acid is dissolved.—*Trans.*

speedily and entirely dissolves a large proportion of uric acid ; but that a more concentrated solution is less effectual.*

This accords with the results of my own experiments on the subject. Employing a solution composed of twenty-four grains of borax to six ounces of water, I found that it dissolved nine grains of uric acid, a part of which was re-deposited at the expiration of a few hours. I subsequently tried the acetate of soda, but found it less efficient as a solvent than the biborate. In a comparative experiment, made with the two salts on a calculus composed of uric acid, and basic phosphate of lime, the following circumstances were observed.

The acetate of soda was a better solvent for the phosphate, as was proved by the greater quantity of lime precipitated from it by oxalate of

* For further observations on this menstruum, as well as on solvents in general, the reader should consult Dr. Robert Willis' works, which are replete with information on the subject of calculous disorders.—“ Urinary Diseases and their Treatment,” 1838 ; “ On the Treatment of Stone,” 1842.

ammonia, than from the boracic solution ; whereas, a greater quantity of uric acid was thrown down from the latter than from the former by hydrochloric acid. After being allowed to stand for twenty-four hours, the two fluids were again tested, and with the same results. Forty-eight hours were now suffered to elapse, at the end of which period, however, lime was no longer detectable. These experiments were frequently repeated, and always with the same results.

Boettiger considers that borax would act more efficiently if used as an injection ; and I am much of the same opinion as regards the acetate of soda, if employed as a solvent for phosphatic calculi.

The effects of acetate of potash are precisely similar to those of soda ; but the acetate of magnesia does not possess any advantage over the carbonate.

For the solution of earthy calculi, various vegetable acids have been proposed ; especially the lactic, malic, and citric, on account of the solubility of the salts they form with lime.

Even tartaric acid has been used, but certainly with less prospect of success, owing to the well-known insolubility of tartrate of lime. Most of the mineral acids have been used in turn, but apparently without any satisfactory results.

The vegetable acids, as they unquestionably impregnate the urine with their specific qualities, are calculated to exert some influence on its concretions. The same is said to be the case with respect to carbonic acid; but it must be remembered, that factitious waters, such, for instance, as soda water, are likely to owe their effects rather to the alkali, than to the carbonic acid they contain. If so, the soda water, as at present prepared, by merely condensing carbonic acid in water, is less likely to be available than an effervescing draught made with bicarbonate of soda and a vegetable acid.

Much difference of opinion exists as to the comparative value of the various remedial measures enumerated above. On the one hand, a mass of evidence is brought forward to prove the efficacy of the alkalies, neutral salts, and

vegetable acids, whether taken medicinally, or as articles of diet; whilst there are not wanting those who aver that alkalies, far from being beneficial, are decidedly injurious; tending rather to increase than diminish any existing concretion.

Cases, elucidated by post-mortem examinations, have been brought forward to prove that the relief said to be experienced by patients did not arise from the use of the alkaline medicines they had been taking, but was owing to the stone having either become encysted, or lodged in a sheltered nook behind the enlarged lobe of a diseased prostate.* It has also been stated that the deposition of the phosphates frequently depended on the urine being kept alkalescent by inappropriate medicines. It must be confessed, however, that the experiments brought forward in support of the alkaline treatment, evince more accurate chemical knowledge of the subject, are more numerous, and are in all respects more conclusive.

* These cases are intended to warn against the abuse, not the use of alkaline remedies; but in the present day there is not much danger of falling into errors of this description.

Numerous examples have come under my own observation, in which the action of solvents was evident on inspection ; for instance, Figs. 13, 14, 17, 18, 19, and 28, distinctly represent the surfaces of calculi in an erroded and cellular state from the effects of chemical agents. On first examining these specimens, I was inclined to doubt whether the uneven appearance of the surfaces might not have arisen from adhesion of the calculi to the parietes of the bladder, whereby deposition was suspended on one point, whilst calculous matter was accumulating on others. But on further investigation I found that the cavities and fissures were filled with white saline matter ; and that when a fragment of this calculus was boiled in water, the white substance alone was dissolved ; also that from the refrigerated solution uric acid was precipitated, by the addition of the hydrochloric. From these, and other circumstances not necessary to mention, I was convinced that the calculi in question had been gradually erroded, not indeed whilst the uric acid was recent, but after the cortex, as

well as the adjacent strata, had become consolidated.

If, then, calculi of considerable magnitude and density are susceptible of being acted on in the bladder, there can be no question but that smaller concretions, of more recent formation, not to mention sand and gravel, may be successfully dissolved in that organ, by fluids which act as menstrua out of the body.

In a great number of calculi, their mechanical structure is favourable to the action of chemical solvents; some being made up of loose spongy strata, enclosed within others of a denser texture; some are fissured in various directions, see Fig. 28; and many are wholly or partially excavated, so that in many instances they have been spontaneously ruptured in the bladder itself. Our museum contains a large quantity of fragments of this kind, passed by a patient who had been taking aerated alkaline water. It also contains the singular specimen represented by Fig. 5, a calculus formed of an aggregation of segments, joined edgewise to each other; each of these

junctions would have offered facilities for the action of proper menstrua.

It has frequently been proposed, that instead of taking chemical solvents into the stomach, they should be injected into the bladder, so as to be placed in immediate contact with the stone. Now, certainly, if this can be done without injury to the coats of the bladder, it appears to be the most certain, as it is the most direct way of using lithontriptics. The difficulty has hitherto been, the discovery of a solvent which, whilst it acted energetically on the calculus, should exercise no injurious effect on the animal tissues.*

Although it does not, strictly speaking, come within the province of this work to notice mechanical means of removing calculi, it may not be irrelevant to allude to an agent, intermediate

* Dr. Scharling does not seem to be aware of Sir B. Brodie's successful employment of very dilute nitric acid as a lithontriptic injection, and that other English surgeons have adopted the practice in various cases. See *Sir B. Brodie's Lectures; Coulson on the Bladder and Prostate*, p. 113.—*Trans.*

between the mechanical and the chemical, or rather a combination of both, viz. Voltaic electricity. Numerous experiments are quoted of the effects of this powerful and subtle agent on the inferior animals, and on calculi out of the body; but none have been mentioned in which any approach to success has attended its application to calculi in the living human bladder.

DESCRIPTIVE CATALOGUE

OF

CALCULI IN THE ROYAL SURGICAL MUSEUM OF COPENHAGEN.

* 1. Fragments, the surfaces bear evidence of the action of solvents. The body consists of layers, more or less dense, of uric acid and urate of ammonia. The residue, after incineration, contained traces of lime, magnesia, silix, and iron.
Weight, 6 oz.

2. Figs. 13 and 14. See plates.

3. Oval, the cortex, a mixture of uric acid and fusible phosphate, is grey; beneath this, uric acid and urate of ammonia are found. The surface is porous. *Weight, $1\frac{1}{2}$ oz. 120 grs.*

4. Fig. 1. See plates.

*The numbers refer to the compartments in which the specimens are contained.

5. In fragments ; the nucleus, oxalate of lime ; outer layers, fusible matter with uric acid.

Weight, 1 oz. 180 grs.

6. Fig. 20. See plates.

7. Nearly oval ; the nucleus, urate of lime ; the rest of the mass, alternating layers of uric acid, urate of ammonia, and oxalate of lime.

Weight, 1 oz. 10 grs.

8. Mulberry calculus ; the nucleus, oxalate and urate of lime ; principal mass, oxalate of lime.

Weight, $1\frac{1}{2}$ oz. 130 grs.

9. Nucleus, oxalate and urate of lime ; adjacent strata containing urate of ammonia ; cortex, fusible matter. *Weight*, 1 oz.

10. Fig. 32. See plates.

11. Mulberry calculus ; nucleus, uric acid and urate of lime ; body, oxalate of lime ; cortex, fusible matter. *Weight*, 1 oz. 100 grs.

12. The same, but the oxalate of lime more dense in texture. *Weight*, $1\frac{1}{2}$ oz. 40 grs.

13. Oval ; body, oxalate of lime with a small quantity of uric acid ; cortex, fusible matter. *Weight*, 87 grs.

14. Fig. 19. See plates.

15. Mulberry calculus, with a dense cortex of fusible matter. *Weight*, 220 *grs.*

16. Similar to the above. *Weight*, $\frac{1}{2}$ oz. 120 *grs.*

17. Nucleus, urate and oxalate of lime; succeeding layers, oxalate of lime, with triple phosphate: cortex, fusible matter. *Weight*, $\frac{1}{2}$ oz. 30 *grs.*

18. Fig. 33. See plates.

19. Oval, internally oxalate of lime; covered with a dense layer of fusible matter. *Weight*, 190 *grs.*

20. Very porous, with several nuclei; composed entirely of fusible matter, with a very small quantity of uric acid. *Weight*, $\frac{1}{2}$ oz.

21. Cortex only of a calculus in fragments, consisting of urate of ammonia and fusible matter. *Weight*, $\frac{1}{2}$ oz. 210 *grs.*

22. Fig. 39. See plates.

23. A loose porous mass consisting of triple phosphate with a trace of uric acid. *Weight*, 90 *grs.*

24, 25, 26, 27, 28. Fragments which contain

phosphates of magnesia and lime, with carbonate of lime, a trace of uric acid, and urate of ammonia. They are difficult of fusion.

29. Biliary calculi.

30. A fragment, the cortex of which consists of uric acid, surrounding a black mass of oxalate of lime.

31. Laterally compressed; it contains two nuclei of urate of soda; the external layers are uric acid. *Weight*, $\frac{1}{2}$ oz.

32. See plates, Fig. 46. The whole is a fusible calculus. *Weighing* 16 oz. 56 grs.

33. Also fusible, with a portion of carbonate of lime; the calculus contains several nuclei, and is of a very irregular form. *Weight*, $10\frac{1}{2}$ oz. 48 grs.

34. Uric acid, smoothly tuberculated in some parts. *Weight*, $2\frac{1}{2}$ oz. 120 grs.

35. Body, uric acid in dense and spongy layers alternating; the cortex contains a quantity of triple salt. *Weight*, 2 oz. 120 grs.

36. Smooth and oval, the whole composed of uric acid, but the nucleus is less dense than the exterior. *Weight*, $2\frac{1}{2}$ oz. 140 grs.

37. See plates, Fig. 2.

38. Nearly similar in figure to No. 8, consisting of uric acid ; the surface exhibits traces of the action of a solvent. *Weight*, 1 oz. 180 grs.

39. See plates, Fig. 48.

40. Two calculi, one consists of oxalate of lime, with a thick crust of triple phosphate. Exterior to this a thin coating of uric acid, which is a rare occurrence. *Weight*, $\frac{1}{2}$ oz. 30 grs. The other is a mulberry calculus with a nucleus of oxalate and urate of lime. The cortex consists of a thin layer of fusible matter. *Weight*, 180 grs.

41. See plates, Fig 25.

42. See plates, Fig. 16.

43. Mulberry calculus with a dense external coating of fusible matter. *Weight*, $\frac{1}{2}$ oz.

44. See plates, Fig 47.

45. Siliceous calculus. *Weight*, 140 grs.

46. Spherical, consisting of triple salt and fusible matter. *Weight*, 30 grs.

47. Contains several nuclei, which, as well as the body, consist of uric acid ; cortex, triple phosphate. *Weight*, $\frac{1}{2}$ oz. 120 grs.

48. Fragments of fusible matter, with oxalate of lime and uric acid.

49. Fragments, internally composed of urate of ammonia and lime, with oxalate of lime; the exterior is fusible matter.

50. See plates, Fig. 10.

51. See plates, Fig. 38.

52. See plates, Fig. 4.

53. Smooth and oval, similar to No. 52, except that it has a thin coating of urate of potash and triple salt. The surface exhibits signs of the action of solvents. *Weight*, $1\frac{1}{2}$ oz. 180 *grs.*

54. See plates, Fig. 3.

55. See plates, Fig. 18.

56. See plates, Fig. 45.

57. Section consisting of mulberry calculus, with a thick layer of fusible material and an abundance of carbonate of lime. *Weight*, 200 *grs.*

58. See plates, Fig. 35.

59. A fragment made up of triple phosphate with an internal layer of fusible matter, and traces of uric acid and oxalate of lime.

60. See plates, Fig. 30.

61. See plates, Fig. 23.

62. A flattened calculus; the interior composed of a mixture of mulberry and fusible matter, surrounded by uric acid; and, finally, a thick crust of triple phosphate. *Weight*, $\frac{1}{2}$ oz. 30 *grs.*

63. An irregularly-formed calculus of fusible matter. *Weight*, 15 *grs.*

64. A trilateral pyramid, with rounded edges, the body composed of uric acid; the cortex of fusible matter, of a dark colour, and low sp. gr. *Weight*, 180 *grs.*

65. A section of fusible calculus, the triple salt preponderating.

66. See plates, Fig. 26.

67. Smooth and oval, composed entirely of uric acid; the nucleus and body spongy; cortex of a denser texture. *Weight*. $\frac{1}{2}$ oz. 200 *grs.*

68. See plates, Fig. 24.

69. See plates, Fig. 12.

70. Consists of tolerably dense uric acid, intersected in various places by fissures; the surface tuberculated. *Weight*, $4\frac{1}{2}$ oz. 100 *grs.*

71. Smooth and oval; uric acid in layers of various density. *Weight*, $3\frac{1}{2}$ oz. 120 *grs.*

72. See plates, Fig. 45.

73. See plates, Fig. 27.

74. Smooth and oblong; the surface in some places appears erroded by a solvent. *Weight*, $1\frac{1}{2}$ oz. 199 *grs.*

75.

76. See plates, Fig. 6.

77. See plates, Fig. 7.

78 and 79. Two calculi of uric acid, surrounded with metallic rings.

80. Reniform calculus, said to be extracted by Griffenfeld.

81. Several small calculi of uric acid.

82. An oval calculi of uric acid; the nucleus and cortex compact; the intermediate layers spongy. *Weight*, $\frac{1}{2}$ oz. 100 *grs.*

83. Smooth and oval, studded with a few tubercles of oxalate of lime; the general mass composed of uric acid and urate of lime. *Weight*, 132 *grs.*

84. Oval, uric acid. *Weight*, 2 oz. 126 *grs.*

85. Empty.

86. See plates, Fig. 11.

87. See plates, Fig. 32.

88. A section, the interior urate and oxalate of lime; the exterior fusible matter; the nucleus, which is very black, contains a considerable quantity of carbonate of lime.

89. Smooth, oval, and rather spongy, consisting of uric acid. *Weight*, 100 *grs.*

90. Similar to the former, but containing more fibrous matter. *Weight*, 200 *grs.*

91. Smooth and oval; nucleus, urate and oxalate of lime; exterior, uric acid; intermediate layers, urate of ammonia. *Weight*, 136 *grs.*

92. Oval; somewhat hard; the nucleus consists of uric acid and urate of lime; the cortex urate of magnesia and triple salt; the intermediate structure abounds with urate of lime. *Weight*, $\frac{1}{2}$ oz.

93. Oval; the nucleus is uric acid and urate of lime; the body consists chiefly of urate of ammonia; the cortex fusible matter and urate of lime. *Weight*, 130 *grs.*

94. Smooth, urates of ammonia and lime,

similar to a coffee-berry in colour. *Weight*, 10 *grs.*

95. Flattened, very porous, consisting of uric acid. *Weight*, 28 *grs.*

96. See plates, Fig. 15.

97. Oval, smooth, composed of uric acid. *Weight*, 27 *grs.*

98. Nucleus, urate and oxalate of lime; cortex, uric acid. *Weight*, 208 *grs.*

99. See plates, Fig. 31.

100. Mulberry calculus, with a thick layer of fusible matter, which, being deposited at the two extremities, gives it an oval form. A deep fissure traverses the whole of the interior, but not the cortex. *Weight*, $\frac{1}{2}$ oz. 45 *grs.*

101. Oval, spongy, composed of uric acid. *Weight*, $1\frac{1}{2}$ oz.

102. Irregular form, the nucleus not in the centre, composed of uric acid with urate and oxalate of lime; the body of fusible matter and uric acid. *Weight*, 60 *grs.*

103. A section; fusible matter with urate and oxalate of lime.

104. See plates, Fig. 40.

105. Oval, smooth; uric acid in alternate compact and spongy layers. *Weight*, 2 oz.

106. See plates, Figs. 19 and 20.

107. See plates, Fig. 37.

108. A section, containing a large quantity of triple phosphate.

109. Biliary calculi.

110. See page 79.

111. See page 29. Fragmental segments.

112. Half of a cubical calculus of uric acid, which appears to have been hollow.

113. A section; the nucleus, urate and oxalate of lime, with the addition of triple salt in the external layer. *Weight*, 100 grs.

114. Smooth, nearly cubical; the interior, mulberry; the exterior, fusible matter. *Weight*, 100 grs.

115. A section, composed of oxalate and urate of lime and fusible matter.

116. Smooth, resembles a plum-stone in form; consists of uric acid. *Weight*, 35 grs.

117. A section, principally composed of urate of ammonia. *Weight*, 20 grs.

118. Several small calculi; the larger, fusible matter; the lesser, uric acid.

119. Empty.

120. See plates, Fig. 42.

121. Empty.

122. See plates, Fig. 44.

123. Oval, formed of distinct layers of triple phosphate; between the layers a number of small crystals are visible. *Weight*, $1\frac{1}{2}$ oz. 60 grs.

124. See plates, Fig. 8.

125. Reniform; uric acid in dense and spongy strata alternating. *Weight*, 180 grs.

126. See plates, Fig. 9.

APPENDIX,

CONTAINING

DETAILS OF THE ACTION OF REAGENTS ON
CALCULOUS INGREDIENTS;

A CLASSIFICATION OF CALCULI SO AS TO FACILITATE
EXAMINATION AND DISCRIMINATION :

AND,

TABULAR VIEWS OF THEIR PHYSICAL AND OTHER
CHARACTERISTIC PROPERTIES.

APPENDIX.

ACTION OF REAGENTS ON CALCULI.*

Acetic Acid.

1. This acid dissolves triple phosphate, but it neither acts on phosphate of lime, nor on uric acid ; and is, therefore, the best agent for the separation of these principles, so that each may be examined apart. The powdered calculus is digested in dilute acetic acid, and, when the whole of the triple salt is dissolved, the insoluble ingredients are separated from it by filtration. The

* These reagents should be perfectly pure, and distilled water must be used for their solution.

addition of caustic, or sesquicarbonate of ammonia, to the clear solution, precipitates the triple phosphate without decomposition.

2. It dissolves the carbonates with effervescence, and affords the means of separating them from the phosphate of lime. Any triple salt that may chance to be present, is also dissolved at the same time, and is precipitable by hydrochlorate of ammonia : see page 74.

3. The fibrinous calculus, when boiled in acetic acid, first of all, increases considerably in bulk, and then dissolves. The addition of ferro-cyanate of potash to the clear solution, produces a yellow precipitate.

4. It dissolves the colouring matter, alone, of uric acid calculus; and acquires from it a yellow tinge.

5. It dissolves uric oxide sparingly and slowly.

6. It is the readiest agent for precipitating cystine from its solution in the alkalies; the precipitate crystallizes slowly, in colourless, transparent, hexagonal plates.

7. It precipitates uric acid from its solution in

caustic potash, in the shape of a white granular powder. The identity of this precipitate may either be ascertained by the lozenge-shaped crystals which subsequently form; or by testing it with nitric acid and ammonia. See §§ 25, 53.

Carbonic Acid.

8. A stream of this gas *readily* precipitates uric oxide from its solution in caustic potash. The precipitate is *not* soluble in warm water.

9. It also precipitates uric acid from its potash solution, in the form of a bulky jelly. This precipitate, which consists of urate of potash, is *soluble* in tepid water.

Citric Acid.

10. This is one of the acids in which cystine is insoluble, and by which it is precipitated from its alkaline solutions.

Concentrated Hydrochloric Acid.

11. The strong acid is as sparing a solvent for uric acid as water, and does not decompose it like nitric acid.

12. By long digestion, or boiling, it dissolves oxalate of lime calculus, when reduced to powder.

13. It is a test for ammoniacal fumes, which become visibly white and dense, the instant they come in contact with a rod or slip of glass, moistened with strong hydrochloric acid.

Dilute Hydrochloric Acid.

(1 acid + 9 water.)

14. This acid is preferred for precipitating uric acid from its solution in caustic alkali; because, uric acid is neither decomposed nor dissolved by it.

15. It also precipitates uric acid from aqueous solutions of the urates of ammonia, potash, soda, lime, and magnesia, by combining and forming soluble salts with either of these bases,—setting the uric acid free. The precipitate formed is a white granular mass, which crystallizes on drying.

16. Hydrochloric acid dissolves phosphate of lime, triple phosphate, and consequently fusible calculus. It is therefore very useful for separating

the whole of these salts from uric acid ; the latter, being much less soluble in hydrochloric acid, precipitates, and may be obtained distinct by filtration or decantation.

17. The phosphates themselves are recoverable from the solution by neutralizing it with ammonia. The precipitate which is produced, after being well washed, may be treated with acetic acid to dissolve the triple phosphate, see § 1 ; or with dilute sulphuric acid. See pp. 57, 63, § 37.

18. It dissolves carbonates of lime and magnesia, with effervescence *before* incineration. See § 30.

19. The disengagement of carbonic acid serves to distinguish the carbonates from other compounds. The gas may be identified by its being colourless, tasteless, inodorous ; and by rendering lime-water turbid. The neatest method of operating with a small fragment, is to drop it into a diminutive tube-retort containing water ; to add a drop or two of hydrochloric acid, and to immerse the *beak* of the retort into a small test-tube half

full of lime-water, so that the gas as it generates may pass through this fluid.*

20. Dilute hydrochloric acid dissolves mulberry calculus, either by boiling or long digestion. After calcination, however, when the oxalate is converted into carbonate of lime, it dissolves it readily, with effervescence. See § 31.

21. It is one of the acids which dissolves cystine. Berzelius says, that when a saturated solution of this kind is carefully evaporated, a salt composed of cystine combined with the acid is obtained in the shape of divergent acicular crystals, of an austere taste; they are decomposed by slight elevation of temperature, the acid being volatilized, and the cystine forming a black residue.

22. It is useful for detecting the bases usually united with uric acid. When any of the urates, therefore, are dissolved in it, the solution on evaporation yields crystals characteristic of the base; it is easy then to determine whether these crystals

* The mechanical arrangement may be seen in "Faraday's Chemical Manipulation," § 924.

consist of chlorides of potash, of soda, or hydrochlorate of ammonia.

Concentrated Nitric Acid.

23. A great excess of this acid decomposes cystine, and, on evaporation, a brown stain remains, which is to be distinguished from the yellow stain of uric oxide, and the pink and purple residue of uric acid. See § 25, 26.

24. It dissolves mulberry calculus by boiling, or long digestion.

Dilute Nitric Acid.

(1 acid + 9 water.)

25. It decomposes and dissolves uric acid, with effervescence. The solution, when slowly evaporated, leaves a pink stain, which becomes a rich purple, by the addition of liquid ammonia.*

26. This is the special test of the presence of uric acid, both free and combined, even when it

* As the ammonia evaporates, the purple hue again gives place to the original pink; but, on adding ammonia the purple is restored.

exists in very minute proportion. One of Griffin's white porcelain capsules, in the shape of a teaspoon, answers admirably well for this experiment.

27. Nitric acid dissolves uric oxide, *without* effervescence; and a yellow, instead of a pink stain, is the result of evaporation. This solution, supersaturated with potash, yields a yellowish-red precipitate; heated with hydrochlorate of ammonia it affords a yellow deposit.

28. The earthy phosphates are as effectually dissolved in this, as in hydrochloric acid; and on adding nitrate of silver to the solution, neutralized by ammonia, phosphoric acid is detected by the yellow precipitate which occurs. See § 61.

29. It is not so effectual an agent for precipitating uric acid from solutions of the phosphates, as the hydrochloric, in consequence of its chemical action on uric acid.

30. It dissolves the carbonates, with effervescence, *before* calcination. See § 18.

31. The mulberry calculus is dissolved by it

slowly, *before* calcination, and without disengagement of gas ; whereas, *after* calcination, solution is rapid, and accompanied by brisk effervescence. This circumstance serves as one mode of distinguishing between the oxalate and carbonate of lime ; the latter effervescing only *before* calcination, the former only *after* the application of heat. When both ingredients are present, effervescence takes place before, as well as after incineration.

Oxalic Acid.

32. Cystine is soluble in this acid. The saturated solution, on evaporation, furnishes crystals of this substance. See § 21.

33. It precipitates lime from acid solutions of that earth ; but if acid they must be previously neutralized : it is by no means so certain a test as oxalate of ammonia.

Phosphoric Acid.

34. This, also, is one of the acids in which cystine is soluble. Added in excess to the phosphates, it renders them soluble likewise.

Concentrated Sulphuric Acid.

35. It dissolves uric acid, which is precipitable by the addition of water to the sulphuric acid; the solvent power is greater, when the acid is moderately warm, than when hot or absolutely cold.

36. It also dissolves uric oxide, which is *not* precipitable by the addition of water. This acid, therefore, offers a means of separating the uric acid from the oxide.

Dilute Sulphuric Acid.

37. When diluted so that its sp. gr. shall not exceed 1.020, this acid dissolves triple phosphate, without acting on phosphate of lime. It serves, therefore, occasionally, to separate these two principles.

38. It dissolves cystine.

Tartaric Acid.

39. This acid precipitates cystine from its solution in the alkalies.

Caustic Potash.

40. A solution of this salt dissolves uric acid entirely. It is the special solvent, as nitric acid aided by ammonia, is the special test of this element. By neutralizing the solution, with hydrochloric acid, a white granular powder subsides, which crystallizes on drying in rhomboid or lozenge-shaped plates. From its alkaline solution uric acid is also precipitated as an urate of potash by carbonic acid gas.

41. Caustic potash in solution also dissolves uric oxide, with which it forms a greenish-yellow fluid, difficult to filter. The oxide is precipitated from it by all the weaker acids; even the carbonic causes it to subside, free from any admixture of potash, in the form of a white powder insoluble in warm water.

42. Cystine is also soluble in caustic potash, and more readily precipitable by the acetic than by other acids.

43. Caustic potash, heated with any calculus containing ammonia, causes the vapour of the

latter to evolve ; which is recognised by the pungency of its odour, and the dense white fumes afforded when it comes in contact with hydrochloric acid gas. This ammonia vapour also causes alkaline reaction on turmeric, and reddened litmus paper. See § 47.

44. It is frequently necessary to decide as to whether ammonia proceeds from the triple phosphate or from urate of ammonia. The combustibility of the latter, but not of the former, constitutes one point of difference,—their relative solubility and insolubility in boiling water is another ; each singly would be enough to decide the question.

45. Mulberry calculus is not acted on by caustic potash ; which, however, dissolves its albumen, or other animal matter, when the powdered calculus is digested in a solution of it. See § 49.

Carbonate of Potash.

46. A strong solution of this salt acts sparingly on uric acid. This forms one of the distinctions between pure uric acid and the urates of ammo-

nia, lime, &c. Berzelius, however, says that a *weak* solution of carbonate of potash slowly dissolves uric acid, and affords a method of separating it from uric oxide.

47. Carbonate of potash affords more distinctive evidence of the presence of ammonia in a calculus than caustic potash does, in consequence of the latter acting in such a manner on animal matter as to cause the generation of ammonia. The carbonate therefore is on the whole preferable.

48. Carbonate of potash in solution dissolves urates of ammonia, soda, potash, &c., readily.

49. It is very useful for decomposing the mulberry calculus. When this material is boiled in a solution of the carbonates, an interchange of principles takes place ; carbonate of lime, an insoluble salt, is formed and precipitates ; oxalate of potash remains in solution. The latter solution may be tested for oxalic acid, by the following salts, viz. nitrate of silver, chloride of calcium, and sulphate of copper ; each of which produces a peculiar precipitate. See §§ 64, 66, 67.

50. Carbonate of potash decomposes the phos-

phates when boiled in a solution of it. The earthy bases precipitate, whilst the potash combines with the phosphoric acid, and remains in solution. It may be recognised in this solution by proper tests, especially by nitrate of silver, which throws down a yellow precipitate of phosphate of silver. See § 63.

51. The above-mentioned solution of phosphate of potash is also decomposed by acetate or nitrate of lead; the oxide unites with the phosphoric acid, and an insoluble phosphate of lead subsides; which, when dried, and fused on charcoal, leaves after cooling a crystalline mass.

Liquid or Caustic Ammonia.

52. This fluid affords the readiest means of determining the presence of cystine. The assay, in powder, must be digested in warm liquid ammonia, and a drop or two of the solution allowed to evaporate spontaneously: crystals will soon appear, the form of which determines the presence of cystine. See page 76. Tabular view at the end of the work.

53. Ammonia transforms the pink stain, produced by evaporating nitric on uric acid, into a rich purple; but it does not change the yellow colour of the uric oxide residue, resulting from a solution of the latter in nitric acid.

54. Ammonia is exceedingly useful for neutralizing acid solutions of the earthy phosphates, which it precipitates in an amorphous, granular form,—these granules subsequently crystallize, and the form of the crystal will enable us to determine the nature of the salt. See Tabular view at the end of the work.

55. It is the best and almost the only test we have for magnesia. It separates this earth from its union with lime in the triple and fusible varieties. Thus, when a calculus is dissolved in dilute hydrochloric acid, the solution must be filtered, and *nearly* neutralized with ammonia,—oxalate of ammonia being now added, precipitates the lime; when the oxalate no longer renders the fluid turbid, the lime must be allowed to subside; if to the liquid, now filtered, ammonia in excess be added, a precipitate of magnesia takes place.

Sesquicarbonate of Ammonia.

56. This preparation is the best agent for precipitating cystine from its acid solutions.

57. It assists also in precipitating magnesia from its acid solutions. Dr. Wollaston's process for this purpose, consisted in adding, to a somewhat concentrated solution of the salt to be tested, first, a solution of sesquicarbonate of ammonia, and then phosphate of soda; whereupon, a precipitate of phosphate of magnesia and ammonia subsided.

Hydrochlorate of Ammonia.

58. A solution of this salt precipitates uric acid from its solution in potash; but, it does not precipitate uric oxide, unless from a very concentrated solution.

59. It precipitates triple phosphate unchanged, from a solution of mixed or fusible calculus in warm acetic acid.

Oxalate of Ammonia.

60. This salt is a most useful agent for detect-

ing lime, and separating it from its combinations. If the solution to be tested, is acid, it should previously be nearly neutralized. The oxalate of lime, which precipitates on the addition of the ammoniacal oxalate, is a white powder, very soluble in nitric acid, less so in hydrochloric, except when in excess; but not at all soluble in acetic acid, even when recently precipitated. By means of this test, lime may be detected in solutions of the phosphates, carbonates, oxalates, and urates.

Nitrate of Silver.

61. A solution of this salt is used to detect phosphoric acid. For instance, a solution of the calculus, if acid, must be *cautiously* neutralized with ammonia; a drop or two of nitrate of silver solution added to it will determine the precipitation of yellow phosphate of silver.

62. Or, a few drops of the nitrate may be added to the calculous solution in the first place; then, on gradually adding dilute liquid ammonia, the distinctive yellow precipitate will be formed.

63. The same kind of precipitate takes place on adding nitrate of silver to the solution of phosphate of potash, resulting from the decomposition of triple phosphate, &c. See § 50.

64. It is applicable also to determining the presence of oxalic acid thus : the addition of nitrate of silver to the oxalate of potash solution, produced by decomposing mulberry calculus with carbonate of potash, see § 49, will cause the deposition of a white sediment. This, which is oxalate of silver, possesses very peculiar properties ; it is unchangeable by boiling, but, when dried and heated, it first of all turns brown at the edges, and then fulminates. The colour, therefore, of the two precipitates :—the phosphate of silver *yellow* and *not* fulminating, the oxalate, *white* and *detonating* on being heated, will point out the nature of the acid when the assays are similarly treated.

65. The oxalic acid is also detected by dissolving mulberry calculus in nitric acid, adding a few drops of nitrate of silver, as before, and neutralizing until the white detonating precipitate of oxalate of silver is produced.

Sulphate of Copper.

66. This salt, as before mentioned, is used for ascertaining the presence of oxalic acid in the solution of oxalate of potash which results from the decomposition of the mulberry calculus; see § 49. On adding sulphate of copper to this solution, a blueish-white precipitate of oxalate of copper takes place.

Chloride of Calcium.

67. This also detects oxalic acid; when added to the above-mentioned oxalate of potash solution it forms a dense white precipitate of oxalate of lime. These three tests, nitrate of silver, phosphate of copper, and the chloride, if used conjointly, are extremely discriminative of oxalic acid.

Nitrate of Cobalt.

68. This salt is useful as a blowpipe test. If an assay, moistened with it, gives a rose-coloured tinge to the flame, magnesia is indicated.

69. The fusible calculus, moistened with it, melts into a brown globule.

70. Added to triple phosphate, it causes the formation of a deep-red vitreous globule.

Turmeric Paper.

71. If this paper, when moistened and held over any escaping vapour, becomes brownish-red, the presence of ammonia is denoted. No other vapour would thus affect the test.

72. It is used also for determining the quality of the residuum, when suspected to contain earthy salts or alkalies.

Reddened Litmus Paper.

73. Detects alkalies by again turning blue ; it is more delicate as a test, when well prepared, than the turmeric paper.

Water.

74. Cold water dissolves, one part in 480, of the urates of ammonia, potash, soda, or magnesia. Urate of lime is less soluble.

75. It precipitates uric acid from its solution in concentrated sulphuric acid.

76. It so sparingly dissolves uric acid under any circumstance, as to be scarcely worth mentioning; for instance *one* part of uric acid requires *ten thousand* parts of water for its solution.

77. Water, at 212° , readily dissolves the urates: from this solution their uric acid is precipitated by the hydrochloric, which combines with the base: if, after the uric sediment has been got rid of, a drop or two of the clear solution is evaporated, the resulting crystals examined by a low magnifying power will indicate the base of the urate. See § 22.

Alcohol.

78. Highly-rectified spirit is useful in determining the precipitation of salts, which, though soluble in water, are not so in alcohol. Used conjointly with sulphuric acid, it ensures a more copious precipitation of sulphate of lime, and is especially useful in quantitative analyses.

RECOGNITION OF CALCULI.

The calculus for examination, especially if recent, should be well washed in water and alcohol, to divest it of any adventitious matter, which, by generating ammonia, would be likely to yield false results.

A small quantity is then to be ignited on platinum foil, by the blowpipe flame. The degree of combustibility at once determines the class to which the specimen undergoing ordeal belongs.*

The proper class being thus ascertained, it becomes necessary to find means for recognising the species and sub-species. Fortunately, a little attention to the phenomena developed by the blowpipe, during the preliminary investigation, will supply the requisite information.

* This examination might, no doubt, be performed by heating the assay over the spirit lamp, which would indicate its class quite as accurately. It would then, however, be necessary to have recourse to chemical tests, in order to determine the species to which it belonged ; whereas, by using the blowpipe from the commence-

For instance, among the species and subspecies belonging to the FIRST CLASS, crepitation, or non-crepitation; the evolution, or non-evolution of ammonia, will serve to distinguish between the pure uric acid calculus, and that composed of urate of ammonia.

In the SECOND CLASS, the *ready* fusibility of the one species, the *difficult* fusibility of the second, and the comparative *infusibility* of the third, enable you to distinguish, with tolerable accuracy, between the fusible, the triple phosphate, and the phosphate of lime calculus.

ment, so much collateral information is obtained as to render other means for distinguishing the species unnecessary.

The only objection which can, by any possibility, be urged against the use of the blowpipe, is that which was formerly urged against the stethoscope, viz. the period of education requisite for acquiring dexterity. In this case it need not exceed a quarter of an hour. In other respects the apparatus is cheap and portable, consisting, besides a small blowpipe, of a miniature platinum capsule. Nothing more is required for bringing it into operation than a common candle. Minute directions for blowpipe manipulation are to be found in every popular work on chemistry.

The intumescence of the assay into a white efflorescent mass, effervescing with acids only *after* ignition, distinguishes the mulberry from other forms of calculus.

As the individuals in the first group or class are destructible by heat, it is evident that we must either be satisfied with the results of this examination, or operate upon a fresh portion of calculus.

In the second group, although the existence and nature of any destructive material may be inferred from the effects of heat, attention is chiefly to be directed to the behaviour of the residuum.

The individuals of the THIRD CLASS claim attention, both for the destructible, as well as the indestructible materials they consist of. Each of these properties must, therefore, be studied in order to arrive at a correct knowledge of the components of the calculus.

CLASS I.

(COMBUSTIBLE CALCULI,)

Contains the following species and sub-species.

- a* Uric acid. { Charrs before B. P., emits odour of burnt horn and hydrocyanic acid but scarcely a trace of ammonia. Heated in the exterior flame, it gradually decreases in bulk, and suddenly inflames; it remains incandescient even after the discontinuance of the blast.
- b* Uric oxide. { Splits, with slight crepitation, into small pieces; these char, and emit a peculiar animal odour, unlike that of cystine or uric acid.
- c* Cystine. { Quickly inflames, burns with a bluish-green flame, and evolves a penetrating odour like that of sulphuret of carbon; the ash is not alkaline.*
- d* Compounds of the above with each other, or with some combustible ingredient. {

Urate of ammonia.	{	Decrepitates vehemently, exhales ammonia abundantly, especially if mixed with potash. In other respects, it dissipates, and behaves like uric acid.
Uric acid, with uric oxide.		
Cystine with uric acid and oxide.	{	Rare. †

* A minute ash, not worthy of being called residuum, remains even when pure uric acid is ignited; in this case the ash is alkaline; in a practical point of view it is not of much moment.

† A specimen composed of cystine, urate of ammonia, and mulberry, is described by Dr. Bird.—*Guy's Hospital Reports*.

Observations.—The foregoing class necessarily excludes the fixed alkaline and earthy salts as being incombustible. Uric oxide and cystine are rare, so that we have generally in the examination to deal with uric acid and urate of ammonia only.

But in order to distinguish the ingredients of the sub-species more minutely, should the blow-pipe examination not suffice, the following hints may be useful.

A fragment of the specimen pulverized may be divided into different portions, X, Y, Z. These letters will represent unknown qualities quite as effectually as unknown quantities.

Let Z be tested with nitric acid and ammonia, whereby the existence of uric acid, when present, even in small quantities, either free or combined, will be detected; (see §§ 25, 53;) and distinguished from uric oxide, which yields a yellow stain with nitric acid, unchanged by ammonia. See § 27.

Let Y be dissolved in warm liquid ammonia in order to test for cystine, if its existence be suspected. See § 52.

If the presence of ammonia has not been satis-

factorily determined, let X be dissolved in boiling water, and subsequently treated with hydrochloric acid. See §§ 22, 77. It must be remembered that neither uric acid, uric oxide, nor cystine, are soluble in boiling water.

The means of detecting any of the ingredients may be readily ascertained by referring to the list of reagents.

CLASS II.

(INCOMBUSTIBLE CALCULI,)

Contains the following species and sub-species.

a. Phosphate	{	of ammonia and magnesia.	{ Charrs, exhales ammonia abundantly, and expands into a gray mass, which ultimately, and with difficulty, fuses into a grey pearly globule. If previously moistened with nitrate of cobalt, the globule becomes deep red. The residue is neither alkaline nor soluble in water.
		of lime.	{ Charrs, exhales an animal odour, and whitens, but does not fuse unless the temperature is much increased and long continued. It produces a globule of phosphuret of iron, if first powdered, and fused with borax, and again fused with iron. The residue is neither alkaline, nor soluble in water.
		of ammonia, magnesia, and lime.	{ Fuses with great facility, evolving a very faint odour of ammonia. Previously moistened with cobalt, it fuses into a brown bead. The residue is neither alkaline nor soluble in water.
b. Oxalate of lime.	{	Emits in the first place an urinous animal odour; charrs, then expands into a white efflorescent residual mass, which effervesces with acid, and ultimately becomes caustic lime; it slakes with water, but does not dissolve, and yields alkaline reaction.	
c. Carbonate.	{	of lime.	{ Infusible, charrs, emits odour of burnt horn. The residue does not effervesce, is insoluble in water, and yields alkaline reaction.
		of magnesia.	{ Rare, often united with lime in the calculi of the lower animals.
d. Phosphates and carbonates.	{	Rare.	
e. Siliceous.		Rare.	

Observations. The residuum, in concretions of this class, is chiefly to be attended to. The only volatile principles likely to be found are ammonia, resulting from triple phosphate, and carbonic acid arising from the decomposition of the carbonates and oxalates.

The phosphates are characterized by their three degrees of fusibility, the insolubility of their residua in water, and the absence of alkaline reaction.

The oxalate is distinguished by infusibility, the effervescence of its residuum with acids, and the insolubility of the latter, in water coupled with its alkalinity.

The carbonates only effervesce before ignition; their residuum does not; it is insoluble in water, and yields alkaline reaction.

If further examination be necessary, it resolves itself into two branches, viz. that for the discrimination of the acids and for the bases. A powdered fragment is to be divided into parcels X. Y. Z.

Z may be tested for phosphoric, oxalic, or carbonic acids. See §§ 19, 49, 50, 61, 64.

Y may be tested for bases by acetic, dilute sulphuric, and hydrochloric acids; caustic ammonia, oxalate of ammonia, &c. See each of these tests in the list of reagents.*

* As every calculus contains more or less animal matter, the assay, whatever it may be, first blackens and emits an animal odour. But these circumstances are not to be taken into account, any more than the minute quantity of ash which remains in the foregoing class.

CLASS III.

PARTIALLY COMBUSTIBLE CALCULI.

a. Uric acid and urates	with phosphates.	{ The uric acid and urate of ammonia dissipate, leaving a considerable residue, which is neither alkaline, soluble in water, nor effervescient with acids. The nature of the phosphate will be determined by the degree of fusibility.
	with oxalates.	{ The uric acid and urate of ammonia dissipate with the usual phenomena, leaving a white efflorescent mass of carbonate of lime, which, by continuing the heat, becomes caustic lime, slakes with water, and yields alkaline reaction.
b. Uric acid with urates	of lime.	{ The uric acid dissipates in the usual way, leaving a residuum, which is alkaline, insoluble in water, and effervesces with acids.
	of soda	{ The uric acid, &c. dissipates as usual; but in this case the soda gives the flame a yellow tinge. The residuum is black, soluble in water, and very alkaline. Mixed with silica on charcoal, it fuses into a globule of glass.
	of potash.	{ Exhibits nearly the same character as the former, the fused bead giving a violet tint to the inner flame of the blowpipe.
	of magnesia.	{ After the dissipation of the uric acid, &c., the residue moistened with nitrate of cobalt, and again heated, imparts a rose-colour to the blowpipe flame.

Observations.—The first point to be remarked in the examination of this class, is whether there be any decided evolution of ammonia; which may proceed from the urate, from the triple phosphate, or from both,

The residuum must be examined as to alkalinity, solubility in water, &c. in order to detect the bases.

If the residue be decidedly alkaline, and soluble in water, soda or potash must have been present as a base. If alkaline, but insoluble in water, the base must have been lime, resulting either from the urate, the carbonate, or the calcined oxalate.*

If, finally, the residue is neither soluble in

* Urate of lime is soluble in boiling water; this is one mode of discrimination. Another consists in digesting the specimen in dilute hydrochloric acid, so as to decompose any carbonate or urate that may be present. If the calculus, after this treatment, and after being incinerated, still effervesces, it must have been one of the mulberry variety. The precaution of digesting the assay before applying heat is necessary, for the calculus often contains both carbonate and oxalate of lime, in which case it will effervesce both before and after incineration.

water, nor alkaline, nor capable of effervescing with acid, the calculus is most likely a phosphate.

Directions for the detection of uric, phosphoric, carbonic, and oxalic acids, have been already given ; see § 19, 25, 49, 50, 61, 64.

The means of separating the proximate principles of mixed calculi will be found amply detailed in the body of the work.

TABLE OF THE PRINCIPAL DISEASES OF THE URINE.

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CAUSES.	TREATMENT.	
1. Errors in Diet. 2. Fatigue. 3. Dyspepsia. 4. Arthritis. 5. Dentition.	} I. The Lithic— tend to An intermediate Station is to be allotted to the Oxalate of Lime— pass into } II. The Phosphatic—	I. Diathesis. II. Amorphous Deposits. III. Crystals or Gravel. IV. Concretions or Calculi.*
1. Irritability } of the System. 2. Debility. } 3. Sickly Childhood. 4. "Breaking-up" of the System 5. Injuries of the Spine.		I. Diathesis. II. Amorphous Deposits. III. Crystals or Gravel. IV. Concretions or Calculi.*
* To these must be added— generally consist- ing of	I. The Alternating; { A Lithic Acid, or Mulberry, Nucleus; { An External Crust of the Mixed Phosphates, A special place is to be allotted to	{ Urine Acid, from the Super- lithate of Ammonia. { 1. Lithate of Ammonia, fre- quently mixed with the II. Lithates of Soda and Lime. Lithic Acid, nearly pure. { 1. The Lithic Acid. II. The Lithate of Ammonia. Urine nearly natural. The Mulberry, or Hempseed. { Urine Alkaline and abounding in the Phosphates. { 1. Triple Phosphate (of Magne- sia and Ammonia,) mixed with II. Phosphate of Lime. Triple Phosphate. { I. The Triple Phosphate. II. The Mixed { 1. Triple Phos- phate with 2. Phosphate of Lime; or the Fusible Calculus. { 1. Alkalies. 2. Salts with a vegetable Acid, as Rochelle Salt. 3. Mercury.
Principles dissolved in the Urine. { Urea in excess. Sugar. Albumen.	Lastly—The Cystic Oxide; the Xanthic Oxide; the Carbonate of Lime; the Phosphate of Lime alone. Diabetes insipidus; Diabetes. Frequently Disease of the Kidney.	{ These consist of { Phosphate of Lime alone. Urine of high Specific Gravity; as 1,025. { Urine profuse; sp. gr. very high; as 1,050. Saccharine. Urine coagulates by heat. { Scanty when from the Kidney. { Profuse when from the bladder. { From Calculus, or Disease, of the Kidney or Bladder.
Principles mixed with the Urine. { Mucus. Pus. Blood.	{ Scanty when from the Kidney. { Profuse when from the bladder. { From Calculus, or Disease, of the Kidney or Bladder.	{ Blood-letting. Mild Animal Diet. Opium. Dover's Powder. Warm Baths. Carbonate of Iron.

Note.—I am indebted to my much valued friend Dr. Marshall Hall, for the above excellent synopsis.

TABULAR VIEW OF THE DISTINCTIVE CHARACTERS OF CALCULI.

SPECIES.	FORM.	COLOUR.	TEXTURE.	SURFACE.			SIZE.	SP. GR.	CHEMICAL AND BLOWPIPE CHARACTERISTICS.	FORM OF CRYSTALS.
				EXTERNAL.	INTERNAL.					
					CUT.	FRACTURED.				
Uric acid. $C_5 N_4 H_4 O_3$	Ovoid, or spheroid when single. Forming facettes and angles when numerous.	Yellowish fawn; reddish brown; colour of mahogany; never grey or white.	Dense, compact, and frangible.	Smooth, or finely tuberculated.	Smooth and polished, formed of concentric layers and striæ.	Crystalline when pure; earthy when mixed with other ingredients.	From that of a pea to that of a duck's egg.	1.276 to 1.786	Combustible, exhales odour of burnt bone and hydrocyanic acid before B. P. Soluble in nitric acid, yielding pink stain on evaporation, changed to purple by ammonia. Soluble in solution of caustic potash.	Rhomboid, lozenge-shaped plates.
Urate of ammonia. $N_5 C_4 H_7 O_3$	Compressed, spheroid or amygdaloid.	Clay coloured; slate coloured; "couleur de café au lait."	Frangible.	Finely tuberculated.	Smooth and even, thin concentric layers.	Finely earthy; granular like compact limestone.	From that of a pea to that of a marble.	1.225 to 1.720	Combustible, decrepitating and yielding strong odour of ammon. before B. P. Soluble in nitric acid, yielding uric acid reaction. Soluble in boiling water, and carbonated alkalies. Exhales vapour of ammonia when heated with potash.	Amorphous, dark globules surrounded by radii.
Xanthic, or uric oxide. $C_3 N_4 H_4 O_2$	Ovoid, flattened at the sides.	Brownish red, resembling that of cinnamon.	Compact and hard.	Smooth. Resinous lustre when rubbed.	Laminated, neither fibrous nor crystalline.	Partly brown and lustrous, partly white and earthy.	Moderate.		Combustible, splitting into fragments, exh. peculiar fætid odour before B. P. Soluble, without effervescence in nitric acid; yielding lemon yellow stain on evaporation. Soluble in strong sulphuric acid, not precipitable by water.	
Cystic oxide. $C_9 N_2 H_{12} O_8 S_2$	Oval oblong.	Tawny yellow, becoming green in time.	Consistence of wax, resembles stearine in appearance.	Covered with smooth tubercles, or sharp crystalline projections.	Confusedly radiated, but not laminated.	Exhibits a peculiar refractive lustre. May be scraped into a white powder.	Moderate.		Combustible, yields an odour like that of sulphuret of carbon before B. P. Soluble in liquid ammonia, fixed alkalies, and many acids. Insoluble in carbonate of ammonia, acetic, citric, and tartaric acids. Yields a brown stain when dissolved in excess of nitric acid and evaporated.	Hexagonal or roundish tables, opaque in the centre.
Oxalate of lime.	Spheroidal, octohedral, cubical.	Deep brown; olive, or blackish green; dull purple, sometimes whitened with the phosphates.	Very compact and dense.	Spinous and rugged.	Excentric laminae, arranged like fortification agate, smooth and polished.	Uneven, splintery.	Moderate.	1.428 to 1.976	Incombustible and infusible, expands into a white efflorescence before B. P. Soluble slowly in nitric and hydrochloric acids, without effervescence. The B. P. residue soluble with effervescence in acids. The B. P. residue insoluble in water, yielding alkaline reaction.	Acute octohedrons.
Triple phosphate.	Compressed spheroid; compressed ovoid; pyriform; reniform.	Nearly white.	Friable. Powder not gritty.	Uneven, studded with sharp shining crystals.	Earthy, pulverulent, crystalline; not striated.	Clusters of crystals imbedded in friable matter, or lining the walls of cavities and fissures.	Large.		Incombustible, fuses with difficulty, evolves ammonia before B. P. Soluble in dilute hydrochloric, nitric, and acetic acids. Precipitable without decomposition by ammonia. The B. P. residue insoluble in water and not alkaline. The B. P. residue soluble without effervescence in acids; yields precipitate of magnesia when ammonia is added to the acid solution in excess.	Rectangular prisms, or some modification of that form.
Phosphate of lime.	Spheroidal.	Pale brown, or greyish white.	Compact.	Smooth, polished, and pore-laneous.	Laminated; the layers easily separable; striated perpendicularly to the surface.	Semi-crystalline; conchoidal.	Moderate.		Incombustible, infusible except under intense heat before B. P. The B. P. residue soluble in hydrochloric and nitric acids. The B. P. residue insoluble in acetic or very dilute sulphuric acids. The B. P. residue insoluble in water, not alkaline.	Amorphous.
Fusible.	Very irregular; round; pyriform; reniform; lobulated.	Quite white.	Very white, leaving a chalk-like streak.	Spongy, rough, not tuberculated nor spinous.	Indistinct layers, united by crystals of triple phosphate.	Earthy, with clusters of triple phosphate sprinkled throughout.	Generally large, frequently very large.	1.140 to 1.470	Incombustible, speedily and readily fusible into a white bead before B. P. The B. P. residue soluble in acids without effervescence. The B. P. residue insoluble in water and not alkaline.	
Carbonate of lime.	Perfectly spherical.	White.	Friable.	Smooth.			Very small		Incombustible and infusible. Soluble in acids with effervescence. The B. P. residue soluble in acids without effervescence.	

